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Reference H Piloted Assessment (LaRC.1) Pilot Briefing Guide

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Introduction

This document describes the purpose of and method by which an assessment of the Boeing Reference H High-Speed Civil Transport design will be evaluated in the NASA Langley Research Center's Visual/Motion Simulator. Six pilots will be invited to perform approximately 60 different Mission Task Elements that represent most normal and emergency flight operations of concern to the High Speed Research program.

The Reference H design represents a candidate configuration for a High-Speed Civil Transport, a second generation supersonic civilian transport aircraft. The High-Speed Civil Transport is intended to be economically sound and environmentally safe while carrying passengers and cargo at supersonic speeds with a trans-Pacific range.

This simulation study is designated "LaRC.1" for the purposes of planning, scheduling, and reporting within the Guidance and Flight Controls super-element of the High-Speed Research program. The other major Guidance and Flight Controls simulation experiments referred to in this document are described below:

LaRC.0	This was the first full-envelope assessment of the Reference H design. LaRC.0 was conducted at NASA Langley Research Center in the Visual/Motion Simulator in December 1995 using Cycle 2B release of the Reference H simulation model.
TIFS.1	This experiment involved flight of the Air Force Wright Laboratories Total In-Flight Simulator aircraft, a modified C-121H with variable stability and control capability. It was conducted by Calspan Corporation in Buffalo, Nw York during May 1996.
Ames.1	This was an evaluation of different longitudinal control response types. Ames.1 included a longitudinal control power criteria study. Ames.1 was conducted in the NASA Ames Research Center Vertical Motion Simulator in June 1996 using Cycle 2B release of the Reference H simulation model.
Ames.2	This simulation experiment compared three control inceptors: wheel & column, center stick, and sidestick in the Ames Vertical Motion Simulator using the Cycle 2B model. It was conducted in the fall of 1996.

The present experiment, LaRC.1, will include the latest control laws from industry partners Boeing and McDonnell-Douglas. These control laws will include an evaluation of envelope protection algorithms for the first time in a Reference H piloted assessment. In addition, an evaluation of the effect of the vehicle's structural dynamics (due to the inclusion of a model of the aeroservoelastic modes of the flexible structure) upon flying qualities in selected maneuvers will be conducted.

[Note: When originally distributed as an information document to participating test pilots in advance of the study, this document was written future tense. In an effort to make minimal changes, the future tense was kept in this revision which includes grammatical corrections and minor clarifications and style changes to fit the formal NASA publication series.]

Nomenclature

m.a.c.	Mean Aerodynamic Chord
AGL	Above Ground Level
CDU	Cockpit Display Unit
CG	Center of Gravity

CHR	Cooper-Harper rating
CRT	Cathode-Ray Tube
DME	Distance Measuring Equipment
DIA	Denver International Airport
EAS	Equivalent Airspeed
HUD	Heads-Up Display
HSCT	High Speed Civil Transport
HSD	Horizontal Situation Display
IAG	Niagra Falls International Airport
I.C.	Initial conditions
LaRC	Langley Research Center
$\mathbf{M_{mo}}$	Maximum Operating Mach Number
MTE	Mission Task Elements
MTOGW	Max Takeoff Gross Weight
MZFW	Max Zero-Fuel Weight
OEO	One Engine Out
PF	Pilot Flying (evaluation pilot)
PFD	Primary Flight Display
PIO	Pilot-Induced Oscillation
PLR	Programmed Lapse Rate
PNF	Pilot Not Flying (test engineer)
RFLF	Recovery from Limit Flight
RTO	Rejected Takeoff
SPD	Surface Position Display
SSB	Simulation Systems Branch
TOGA	Takeoff/Go-Around
TIFS	Total In-Flight Simulator
VHD	Velocity/Height Display
$\mathbf{V_{min}}$	Minimum Operating Speed
$\mathbf{V_{mo}}$	Maximum Operating Speed
$\mathbf{V_{MCA}}$	Minimum Control Speed, air
$\mathbf{V_{MCG}}$	Minimum Control Speed, ground
$\mathbf{V_{MCL-2}}$	Minimum Control Speed, landing, two engines out
VMS	Visual Motion Simulator
$\mathbf{V_r}$	Takeoff Rotation Speed
$\mathbf{V_1}$	Takeoff Decision Speed
$\mathbf{V_2}$	Takeoff Safety Speed
XVS	Enhanced Vision System

Purpose of Assessment

The 1997 Piloted Reference H Assessment test at NASA Langley will be performed using the Boeing Reference H simulation model (Cycle 3). The purpose of the assessment is to evaluate and quantify operational aspects of the model from a pilot's perspective.

This study (LaRC.1) is the second full-envelope assessment of the Reference H model; the first was conducted at Langley in the fall of 1995 and focused upon the vehicle's basic configuration with little regard to the control system. This assessment will include the latest control laws, known as the $\dot{\gamma}V$, or "gammadot-V," longitudinal law and the $p\beta$, or "p-beta," lateral/directional law. In addition, this assessment will contain the first evaluation of certain envelope protection features of these latest control laws as well as an evaluation of the effect of the vehicle's structural dynamics (due to inclusion of the aeroservoelastic modes of the flexible structure) upon flying qualities in selected maneuvers.

Other simulation studies of the Reference H model have been conducted, both piloted and in batch analysis, including simulation evaluations by Boeing, McDonnell-Douglas, Calspan, and NASA Ames Research Center. This is the first assessment of the Cycle 3 release, however.

Ref. H Configuration notes

Cycle 3 model origins

This LaRC.1 test will be based upon the so-called "Cycle 3" version of the aircraft mathematical model. This was published by Boeing Commercial Aircraft Group in the summer of 1996 as the fourth major release in a series of increasingly detailed math models of the Reference H design.[1] The Cycle 3 release has improved-fidelity models for aerodynamics, inertia, engines, landing gear, and actuation systems.[2] The model includes quasi-elastic flexible aerodynamic effects and actuator hinge moments and an engine inlet model that predicts and models the supersonic inlet unstart phenomena. This unstart capability will be a factor in the assessment.

The simulation model is based upon a combination of wind tunnel and computational fluid dynamics studies of the Ref. H design, ranging from low subsonic to 2.4M supersonic wind tunnel studies. In addition, finite-element structural models have been evaluated for strength, rigidity, and flutter dynamic predictions; information from these computations are used to predict the effect of steady flight loads upon aerodynamic stability derivatives.

The Cycle 3 model has been modified from the original release by a series of revisions. The LaRC.1 study will include revisions A, B, C and D to Cycle 3.

Some additional modifications have been made in the implementation of Cycle 3, including the inclusion (for selected maneuvers) of aeroservoelastic (flexible) structural modes. These modifications attempt to capture and recreate the effects of vehicle structural flexibility upon the pilot's flying qualities due to additional higher frequency motion of the cockpit caused by turbulence and pilot inputs to the control system.

General specifications

The design vehicle (Reference H) is approximately 310 feet long with a wingspan of approximately 130 feet and has a MTOGW of 650,000 lb. and a MZFW of 350,000 lb. The fuselage has a maximum diameter on the order of 12 feet, and is expected to carry approximately 300 passengers in three seating classes.

Aerodynamics

The Ref. H vehicle design has a cranked-arrow planform, a conventional aft tail, and four underslung engines. The control devices include a geared horizontal stabilizer and elevator, a three-segment rudder on a fixed vertical fin, eight wing trailing-edge flaperons, four leading-edge flaps, a "vortex fence" device and two "spoiler-slot deflectors" on each wing (see figure 1).

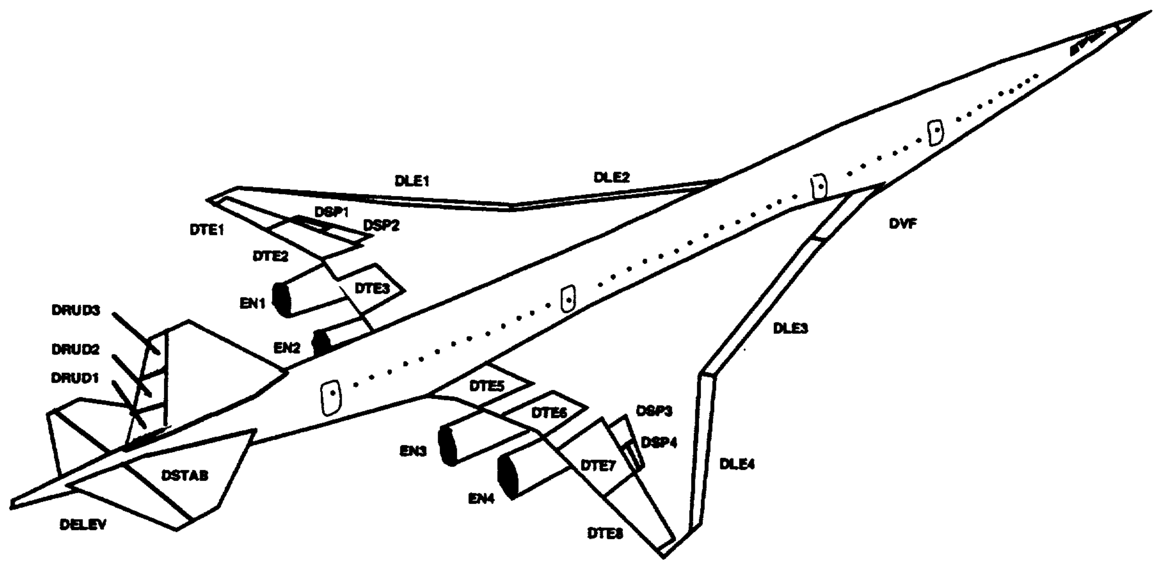


Figure 1. Reference H general arrangement

Operational Concerns

The need to operate within the existing airspace system mandates that the HSCT mix with subsonic traffic in the terminal environment and operate at subsonic speeds. This requires the design to fly most approaches on the "backside" of the drag curve - that is, an increase in power is required to trim for a decrease in speed. This unconventional throttle activity would require extensive retraining of flight crews to successfully accomplish; however, this "backside" characteristic can be masked by using a fairly high-bandwidth autothrottle system. During the LaRC.1 study, landings will be performed with and without autothrottles active.

Noise concerns have caused the examination and design of automatic flap deployment schedules on takeoff and landing maneuvers. Also, a Programmed Lapse Rate (PLR) takeoff procedure has been devised to schedule the autothrottle system during takeoff. This maneuver was investigated in the 1995 assessment. These aspects of the Ref. H design will be further explored in this test.

A fuel-optimal climb and descent profiles that include loft and pushover maneuvers have been designed to meet target range goals. These will be examined in the LaRC.1 study for operational feasibility.

It is anticipated that an operational HSCT will include some enhanced vision system to avoid having to lower the nose for landing. While during this test the visual scene presented to the pilot is not fully representative of an enhanced vision system, the display will include symbology superimposed on the forward view that is similar to proposed XVS symbology. The forward field-of-view is shown at lower resolution and in a smaller field-of-view than that proposed for the operational XVS, however.

The geometry of the Ref. H configuration has been modeled in the simulation so that an accurate assessment of tailstrike, nacelle strike, and wingtip strike can be made during takeoff and landing operations.

Control Laws

The simulation model used in the LaRC.1 test will use control laws that feature flight path rate command/flight path & airspeed hold ($\dot{\gamma}V$) in the longitudinal axis, and a roll rate/sideslip command & bank angle hold system ($p\beta$) in the lateral-directional axes. These laws were developed by Boeing and McDonnell-Douglas, respectively, and have been implemented in the Langley simulation model. These control laws are designed to provide (1) stabilization and control authority over several flight regimes and (2) rudimentary autoflap/autothrottle capability sufficient to perform the various tasks in the LaRC.1 tests. Comments regarding these control laws are encouraged; unlike the previous LaRC.0, evaluation of these control laws is now part of the purpose of this test. Envelope protection features (overspeed and alpha limits) have been added to the flight control system for this test, and will be studied in various maneuvers.

Control Surface Function Allocation

The method of utilizing the available control surfaces for various flight control functions is described in Appendix C.

Propulsion

The engine model included in the Cycle 3 simulation allows for varying levels of detail on engine and inlet operations. At the highest complexity level, the engine inlet simulation reacts to flight conditions that could cause an inlet unstart in supersonic flight on one or more of the four engines being simulated. In general, the inlet is sensitive to small changes in freestream velocity angles - that is, a sudden and non-trivial change in either sideslip angle or angle of attack will cause (usually) the outboard engines to unstart at cruise conditions. The LaRC.1 test will explore the impact of this sensitivity as well as simulate a "ripple" unstart situation in which an inboard engine failure causes the neighboring outboard engine to unstart. Several engine failures in subsonic flight will also be evaluated.

The Ref. H design includes two mixed flow turbofan FE21/F15-A17 engines under each wing, capable of 97,000 lb. of gross thrust each. The axisymmetric inlet includes a translating centerbody spike to adjust the location of the shock wave at cruising speeds.
The outboard engines are located 31.2 feet from the centerline of the aircraft and are canted inward at 2.4 degrees and upward 3.25 degrees relative to the centerline of the aircraft. The inboard engines are located 17.4 feet from the centerline and are canted inward 1 degree and upward 5.7 degrees.

Landing gear

The landing gear design modeled in the Cycle 3 simulation consists of three sets of main gear, located just behind the center of gravity envelope and arranged in left, center, and right sets of tires abreast of each other, and a nose gear. The main gear are located approximately 156 feet behind the cockpit and have an 17.7 ft stance. The nose gear is located approximately 56 feet behind the cockpit. Turning angle of the nose gear is 75 degrees.

Center of gravity and loading envelope

The Ref. H design has an operating empty weight of 280,000 lb. and a maximum taxi weight of 650,000 lb. Final cruise weight is expected to be 385,000 lb. The center of gravity can vary from as far forward as 48.1 % mean aerodynamic chord (m.a.c.) to as far aft as 56.6 % m.a.c. Various LaRC.1 tasks will be flown at these extremes as well as intermediate values of weight and CG as appropriate for the task.

Langley Visual Motion Simulator

Cab arrangement

The Langley Visual Motion Simulator (VMS) is the original synergistic hexapod motion system. The current cockpit configuration includes a left seat Pilot Flying (PF) station and a right seat Pilot Not Flying (PNF) station. A throttle quadrant with four throttles is located between the pilot stations and includes a Cockpit Display Unit (CDU) that will be utilized in the LaRC.1 tests to monitor and adjust various functions of the simulation. A fold-down jump seat is located behind and slightly to the left of the PNF station for an observer. The PNF has two rheostats to adjust cockpit ambient lighting. Four-point harnesses are provided at all seats for motion operation.

Inceptor (left side stick)

The inceptor (controller) to be used for all LaRC.1 tests in the Langley VMS is a McFadden left-handed side stick. The PF seat includes a left-side armrest that is adjustable to provide appropriate forearm support for the left arm of the evaluation pilot.

Visual projection

An Evans & Sutherland ESIG-3000 visual image generator is used to provide out-the-window scenery onto four mirror-beam-splitter monitors: a left and a right side view, and two forward views (one for each pilot). The terminal environment used for takeoff and landing work is a representation of Denver International Airport (DIA). To assist the landing tasks, "desired" and "adequate" landing boxes will be drawn on the image of the primary runway (DIA 35L), along with a target landing reference stripe to either side of the target touchdown aim point.

HUD & other display formats

A simulated Heads-Up Display (HUD) is provided through an electronic video mix with the forward view. Appendix A contains a schematic of this HUD format, which was developed for LaRC.1. Six other CRT displays are provided in the cockpit, arranged to the front and side of either pilot, in addition to the CDU. These displays provide a heads-down Primary Flight Display (PFD), a Horizontal Situation Display (HSD), and a Velocity/Height Display (VHD). It is anticipated that the PFD and HSD will be somewhat familiar to the evaluation pilot; the VHD display was developed for the LaRC.1 test and provides profile climb/descent trajectory information as well as a display of the Ref. H Vmo/Mmo envelope as a function of altitude.

In addition, two specialized displays will be used in the LaRC.1 study: a Surface Position Display (SPD) and a trim display; these are used to monitor the wing flap positions and the engine thrust levels, as well as to ensure proper configuration of the autothrottle and landing gear positions prior to each simulation run.

A scorecard display is also provided at the completion of each run to indicate the numeric value of certain metrics during the run to assist the evaluation pilot in assigning pilot ratings to the various tasks.

Motion characteristics

The motion platform will provide up to ±0.6 g acceleration cues vertically within a 5.75 foot travel envelope; lateral and longitudinal acceleration limits are similar. The angular limits of the Langley VMS are +30/–20° pitch, ±32° yaw, and ±22° roll. (Positive pitch is in the nose up direction.)

Motion cueing will be enabled for the majority of the tasks. Table 1 indicates the use of motion cueing for each task.

Test elements

Task list

The following tasks will be evaluated by each pilot during the LaRC.1 tests:

Takeoff Tasks

- Rejected takeoffs
- Standard acoustic profile takeoff
- Alternate acoustic profile takeoff
- Programmed lapse rate takeoff
- Minimum control airspeed - ground
- One engine out takeoff (no wind and crosswind)

Landing Tasks

- Nominal approach and landing
- TIFS offset approach and landing
- Go-arounds
- Crosswind (15, 25, 35 knot) landings
- Circling approach and landing
- Decelerating approach and landing (autothrottles on and off)
- Minimum control airspeed - landing (two engines)

Airwork Tasks

- Level-off from climb - transonic and supersonic
- Profile climb
- Profile descent
- Initiation of climb - subsonic
- Airspeed change - subsonic climb and subsonic, transonic and supersonic cruise
- Heading change - 5 flight conditions
- Stall series (symmetric and asymmetric power)
- Diving pull-out
- Emergency descent
- Inadvertent speed increase recovery - supersonic
- Two axis upset recovery - supersonic
- Minimum control airspeed - airborne (V_{MCA})
- Inlet unstart

Failure Tasks

- Landing with jammed stabilizer

- Landing without stability augmentation system
- Landing without autothrottle
- Flaperon hardover on takeoff
- Elevator hardover on takeoff
- Flaperon hardover during two-axis upset recovery
- Elevator hardover during two-axis upset recovery
- Autoflap failure during go-around
- Flaperon hardover during crosswind landing
- Elevator hardover during landing
- Degradation of roll power during crosswind landing
- Rudder hardover during landing
- Rudder hardover during landing rollout

Task notes

Refer to Appendix B for the flight cards describing each of the tasks. Table 1 can be used as a cross-reference between flight card number and title, which may be of assistance in using the following notes.

Takeoff Tasks

The takeoff tasks included in this comprehensive full-envelope Ref.-H assessment are designed to exercise the aircraft/pilot/control system over a wide range of scenarios. Maneuvers that are included in this segment are rejected takeoffs (RTOs), one-engine-out (OEO) continued takeoffs, and a series of noise abatement procedures. Maneuvers 1050, 1052, 2010, 2011, 2030, 7035, and 7036 are included in this block. In addition, a maneuver to determine the minimum control speed on the ground (V_{MCG}) is also included, but will not be evaluated by all pilots since it is more of a control demonstration than a handling quality maneuver.

Rejected takeoff maneuvers (tasks 1050 and 1052):

The two RTO maneuvers are designed to evaluate the aircraft's ability to remain controllable while experiencing maximum braking. They simulate the need to reject the takeoff due to an engine failure occurring immediately before reaching the decision speed. Prior to commencing each maneuver, pilots are briefed regarding what to expect. This removes the "surprise" factor of the RTO, but does provide the means to carefully evaluate the scenario. The main pilot's task is to keep the CG of the aircraft within the specified bounds for lateral distance from runway centerline using rudder pedal inputs alone (i.e. differential braking should be avoided, or at least noted if it was used). Maneuver 1050 is performed without cross-winds whereas maneuver 1052 has 35 kt cross-winds. Incorporation of the cross-winds was intended to expose any possible control power deficiencies that might exist.

One-engine-out continued takeoff maneuvers (tasks 7035 and 7036):

To complement the RTO maneuvers, two one-engine-out (OEO) continued takeoffs are included in this block. For these maneuvers, the #4 engine (as shown in figure 1) is failed at a speed just above the decision speed (V_1). This requires the pilot to continue the takeoff. OEO takeoff maneuvers are terminated at approximately 6.0 nautical miles from brake release which provides enough time for the pilot to achieve stabilized flight with the asymmetric thrust condition. Maneuver 7035 is performed without cross-winds whereas maneuver 7036 has 35 kt cross-winds. Maneuver 7036 is probably the most difficult takeoff maneuver to successfully perform due to problems with striking various parts of the aircraft on the ground. Once airborne, however, the pilot's task is not very difficult.

As was the case for the RTOs, the OEO continued takeoffs only have one evaluation segment. When the aircraft is on the ground, the pilot's tasks is to keep the aircraft within specified lateral limits (±10 feet for desired, ±27 feet for adequate performance). At V_r, the pilot is to follow the rotation guidance (maneuvers 2011, 2030, 7035, 7036) to perform a consistent, smooth rotation for lift-off. At V_r -5 kts, the pitch rotation guidance brackets (see the HUD description section) become visible and the reference waterline is doubled in size. At V_r, the rotation guidance brackets begin to move vertically with respect to the reference waterline. They indicate the instantaneous level of pitch rotation error. The rotation guidance brackets are driven to command a 1.5 deg/sec^2 pitch rate acceleration, a 3.0 deg/sec steady rotation rate, and if need be, a 2.5 deg/sec^2 pitch rate deceleration. Pitch rate is arrested only if a tail strike becomes imminent. Desired performance is achieved when the pitch rotation rate error is less than 0.5 deg/sec for 90% of the time. For adequate performance the pitch rotation rate error is increased to 1.0 deg/sec for 90% of the time. In addition to the pitch rate error brackets, a tail strike bar is also included. Once airborne, the pitch rate error brackets, and the tail strike bar are removed from the HUD display.

The pilot's airborne task is to follow the velocity vector guidance symbol. It provides lateral and longitudinal guidance information. Laterally, it provides guidance to follow the extended runway centerline. Longitudinally, it provides guidance to intercept and maintain the desired climb speed. Additionally, a minimum climb gradient (3%) is commanded when the aircraft is unable to accelerate at the specified rate to preclude too shallow of a climb gradient. Desired performance is to keep the commanded velocity vector within one velocity vector diameter of the guidance symbol 90% of the time. Adequate performance is achieved when the commanded velocity vector is within two diameters of the velocity vector guidance symbol 90% of the time.

This criteria may be conceptualized by two imaginary boxes centered around the velocity vector guidance symbol that are three velocity vector symbol diameters in width and height for the desired performance box and five velocity vector symbol-diameters in width and height for the adequate performance box. The goal is to keep the velocity vector within that imaginary boxes 90% of the time. (The metrics for each performance standard are calculated and displayed to the pilot at the conclusion of each run).

In addition, the pilot is to attempt to reduce the sideslip angle to zero using rudder pedal inputs and the sideslip indicator (again, see the HUD description section). No performance metrics are established regarding sideslip excursions.

Acoustic takeoff maneuvers (tasks 2010, 2011, and 2030):

There are a total of three noise abatement maneuvers included in this evaluation. They represent different ideas regarding noise abatement strategies. Maneuver 2010 is designed to be as similar as possible to what was performed during the previous simulation study at NASA Ames Research Center (Ames.2). Automatic flaps are active for this task. Thrust is manually advanced at the beginning of the takeoff, but is then switched to autothrottles during the single thrust cutback at 700 feet. The maneuver violates many FAA FAR regulations and is probably the least realistic noise abatement takeoff maneuver of the three. The pilot's task is very simple. On the ground, the pilot's task is the same as OEO takeoffs, except that no rotation guidance is provided. The only significant on-ground pilot performance metric for maneuver 2010 is that the lift-off pitch attitude be close to 10 degrees. Once airborne, the pilot is required to establish an 8 degree flight path. Given the fact that a flight path command system is employed for this study, this is almost a non-task. At 700 feet, the PNF will reduce the desired flight path to 2.5 degrees, using the CDU, and engage the autothrottles. The pilot's task is to adjust the flight path angle to follow the new desired flight path. There are performance metrics on bank angle and heading which are fairly easy to satisfy. Maneuver 2010 has two evaluation segments. The first segment extends from brake release up to just prior to the thrust cutback. The second segment covers the thrust cutback and the subsequent climb.

One of the least desirable features of this maneuver is that during the initial climb segment, airspeed is increasing rapidly and becomes as much as V2+40 kts. When the autothrottles are engaged to hold V2+10 (212 kts) the thrust is commanded to idle for an extended period of time (as much as 10 seconds in initial evaluations).

Maneuver 2011 was designed to be a takeoff maneuver that an HSCT might employ under current regulations. Therefore, flaps remain fixed at their initial position (LEF=30°/TEF=10°) and thrust is a manual task performed by the PNF. The pilot's task is the same as the OEO takeoff maneuvers (tasks 7035 and 7036). One obvious difference is that a single thrust cutback is performed at 700 feet, whereas no thrust adjustments were made for the OEO takeoff maneuvers. The thrust cutback is intended to be a little more gradual than what was performed for task 2010 which reduces normal acceleration excursions during the maneuver. Since thrust is a manual task, no extreme thrust excursions are encountered, unlike maneuver 2011.

Maneuver 2030 is the most radical noise abatement procedure and offers the maximum reduction of noise suppression required to meet the new proposed Stage-3-X regulations. Noise regulations require that the takeoff noise at two points be below specified levels to gain certification. These two points are sideline noise and centerline noise. Sideline noise is the maximum level of noise measured along a microphone array parallel to the runway centerline and displaced 1476 feet to the side. Results for HSCT aircraft are that the maximum sideline noise is produced when the aircraft is at very low altitudes (approximately 100 feet). Thrust cutbacks performed above this altitude have no effect on the level of sideline noise produced. Sideline noise is also the metric that is the most difficult to meet. Typically, HSCT noise suppresser requirements are determined from sideline noise suppression needs. For this reason, a gradual initial thrust cutback to 75% of maximum thrust is initiated at lift-off. This has the effect of exposing the sideline microphone array with a reduced level of noise. For this maneuver thrust and flaps are under direct computer control. In addition, once airborne, the aircraft is allowed to accelerate up to 250 kts which provides improved aerodynamic performance and subsequently reduces the thrust required to maintain a given climb gradient. When the aircraft reaches 250 kts, the autothrottle system switches into an airspeed hold which has the appearance of being a second cutback.

The pilot's task for 2030 is the same as 2011, 7035, and 7036. The pilot performance metrics are lateral distance from runway centerline while on the ground and in performing the rotation guidance and velocity vector guidance tracking tasks. One apparent difference, however, is that the longitudinal velocity vector guidance is only providing a climb gradient target, which is the same as maneuver 2010. Again, as a result of the constant climb gradient combined with the γ/V control system, pilot activity is significantly reduced. Additionally, since no large climb gradient changes are required, normal acceleration excursions are also greatly reduced.

Landing Tasks

A flight card showing the task definition and performance criteria for the Nominal Approach and Landing (Task 4020) is shown in Appendix B. The task begins in level flight at an altitude of 1500 ft and an airspeed of 190 kts on course for a 30-degree localizer intercept. The pilot uses the ILS localizer and glideslope displays on the HUD shown in Appendix A to perform the approach. At a DME indication of 7.0 NM, autothrottles are commanded to reduce airspeed to the final approach speed of 159 kts. The current procedure for use in the nominal approach includes an automatic reconfiguration of leading and trailing edge devices that is initiated at a gear altitude of 390 ft and is ramped in over a period of 18 seconds. The impetus for this automatic flap reconfiguration is the tradeoff between noise restrictions imposed in the terminal area and the desire to reduce the aircraft pitch attitude at touchdown. The nominal autoflap procedure therefore configures the aircraft for a low speed/ low noise approach down to an altitude of 390 ft at which point the vehicle passes a critical noise-measuring station. Flaps and leading edge devices are then automatically commanded to a high-lift/ low pitch attitude setting of 10 degrees (l.e.) and 30 degrees (t.e.) for the final flare and touchdown, thereby reducing the potential for tailstrike at touchdown. During this period, thrust is increased by approximately 12% and pitch attitude is reduced by approximately 6 degrees to compensate for the flap change. When performing the approach and landing with autothrottles engaged, these changes will occur automatically. When autothrottles are disengaged during the approach and landing, as in the Manual-Throttle Landing (Task 7095), the pilot must advance the throttle levers to compensate for the autoflap reconfiguration which is initiated at 390 ft. A sketch depicting the landing task segment definitions and performance criteria is shown in figure 2.

A Decelerating Approach procedure (Tasks 4220 and 4225) is also being considered as an alternative to the nominal autoflap procedure that has been used to date in the HSCT piloted simulation assessments. This procedure would address several of the concerns associated with the current autoflap procedure, but may also introduce some new issues of concern which the pilot will be asked to enumerate. The decelerating approach will be initialized with the aircraft trimmed at 185 kts instead of the 159 kts used in the nominal approach. This speed will be maintained through glideslope capture, and the aircraft will then follow a deceleration profile designed to bring the airspeed down to 159 kts at the runway threshold. The procedure will allow the use of lower throttle settings during the approach, which should help to address airport and community noise concerns. The procedure also permits the automatic flap transition to be initiated at a higher altitude and to occur less abruptly than in the nominal approach and landing. Pilot comments regarding the acceptability of the decelerating approach procedure are of particular interest. The task will be performed first with autothrottles (Task 4220) and then under manual throttle control (Task 4225).

Crosswind landings (Tasks 4093 and 4095) will also be included in the assessment. One issue to be addressed during the assessment is to define an appropriate decrab procedure for this aircraft. The 25-knot crosswind landing (Task 4093) will be performed using each of the two candidate procedures (A and B) shown on flight card 4093 included in appendix B. The pilot will be asked to declare a preference for one of the two procedures and then to use that procedure to perform the 35-knot crosswind landing (Task 4095). This approach will provide subjective data regarding pilot preference as well as quantitative data in terms of the touchdown performance that each pilot achieved using their preferred procedure. Pilots will also be asked to offer suggested improvements to either of the two decrab procedures.

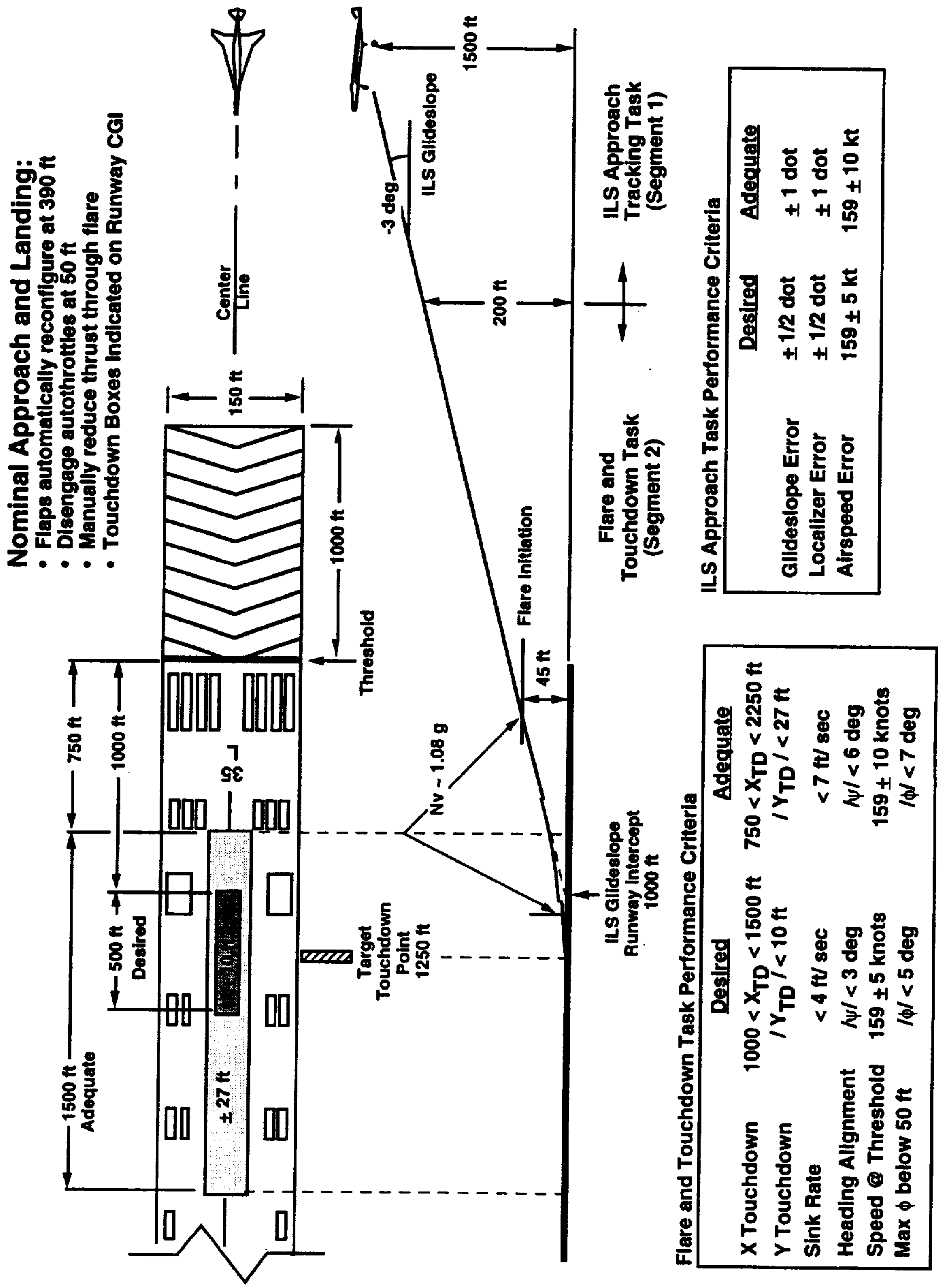


Figure 2. Task definition and performance tolerances for nominal approach and landing.

A new task that has been defined for this assessment is a Circling Approach to Denver International's runway 26 (Task 4140). This task was developed based on pilot comments which reflected a desire to evaluate the aircraft and control system handling qualities in a low-altitude high-workload environment where the pilot may find it necessary to maneuver extensively in close proximity to the ground. The aircraft is initially trimmed at 159 kts on an ILS approach to runway 35R at altitude of 1500 ft with a ceiling of 1000 ft and visibility of 7 NM in a 35 kt crosswind. Upon breakout, the pilot is asked to perform a circling approach to Runway 26 while maintaining a minimum altitude of 750 ft. No head-down NAV display is available for use with this task, so a recommended circling approach profile consisting of a series of turns scheduled with DME is shown in figure 3.

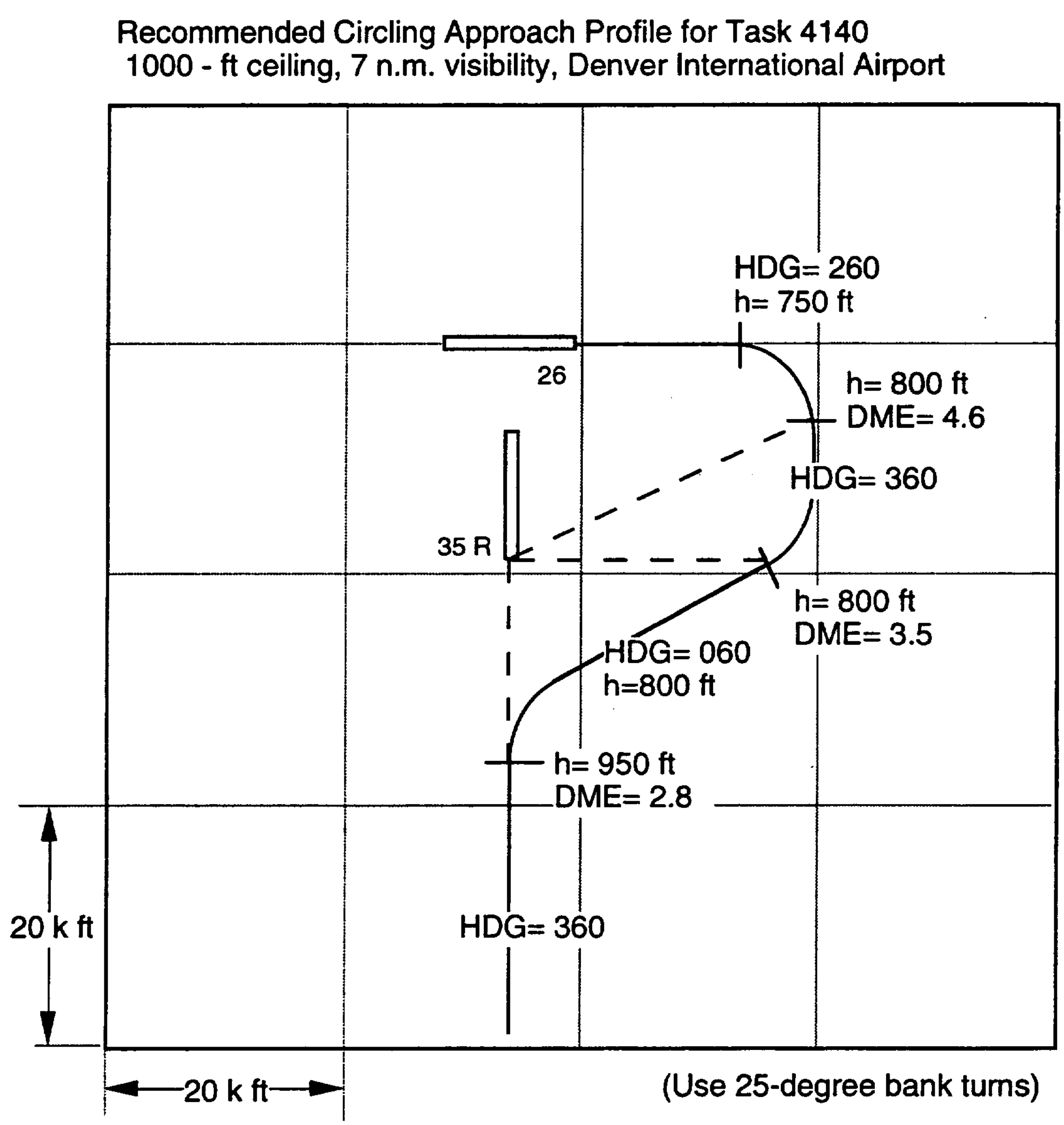


Figure 3. Recommended circling approach profile from Denver International's runway 35R to runway 26 for use in task 4140.

The task is somewhat artificial in that there is no such approach procedure specifically prescribed for use at Denver International. It is also unlikely that the pilot of an HSCT would perform such a circling approach rather than simply executing a missed approach. Nevertheless, the task provides an opportunity for pilots to assess the current vehicle model in a critical VFR operating environment.

Other approach and landing tasks that will be included in the assessment are the IAG Offset Approach and Landing (Task 4069), a Go-Around initiated at gear heights of 50 ft and 30 ft (Tasks 4086 and 4085), and a demonstration of the minimum approach speed for recovery for two-engine failure, Dynamic V_{MCL-2} (Task 4050). Flight cards showing procedures and performance criteria for each of these tasks are included in appendix B.

Airwork Tasks

The LaRC.1 airwork tasks include a variety of maneuvers representing both normal operation and possible certification procedures.

Included in these up-and-away tasks are simple maneuvering tests (heading changes, climbs, level-offs, descents, and accelerations/decelerations) in a variety of flight conditions. More complex manuevers, including stall recovery and certification procedures, are included.

Certification maneuvers, including recovery from a two-axis upset, dive, and overspeed at cruise conditions, will be evaluated. A demonstration of dynamic V_{MCA} will be performed. An emergency descent from cruise conditions following a simulated explosive decompression will be evaluated. The result of a loss of thrust on an inboard engine and an inlet unstart on that engine, with a sympathetic inlet unstart on the neighboring outboard engine, will be demonstrated. An inlet unstart envelope depiction on the HUD symbology will be evaluated.

Profile climbs and descents may be demonstrated, using flight path director guidance to assist the pilot in following the preplanned profile.

The stall maneuvers, also known as recovery from limit flight (RFLF) maneuvers, are designed to test the aircraft's controllability at extreme angles of attack. All aircraft are required to demonstrate that a certain margin exists between normal operational speeds, such as those used for takeoff and landing, and the speed at which the aircraft stalls. Conventional aircraft demonstrate the stall maneuver by increasing the angle of attack until the classical nose-down type of stall characteristics are encountered. Unfortunately, HSCT aircraft stall at angles of attack considerably beyond the angle of attack at which control is lost. Using the theoretical stall speed in this application would produce hazardous results since the aircraft can never fly to, and recover from, a stall condition. Instead, for HSCT applications, a maximum angle of attack demonstration maneuver is employed. The maximum angle of attack is determined from the desired approach speed and weight and applying the appropriate safety margins. For the Ref.-H, the maximum demonstration angle of attack is approximately 21 degrees. Therefore, all of the RFLF maneuvers require the pilot to maneuver the aircraft to 21 degrees angle of attack, then recover.

Upon maneuver initialization, the pilot's task is to follow the HUD guidance to slow the aircraft down at approximately 1.0 kt/sec. All RFLF maneuvers are performed with fixed thrust. HUD guidance includes a biased acceleration arrow and also a velocity predictor bar (see Appendix A) as part of the airspeed tape display. The acceleration arrow indicates inertial acceleration of the aircraft along the flight path. If the acceleration arrow is aligned with the velocity vector (below 15 degrees angle-of-attack) a 1 kt/sec deceleration is achieved. Once the angle of attack is increased above 15 degrees, the acceleration arrow moves up to the reference waterline so that it remains visible to the pilot. The velocity predictor bar indicates what airspeed would be achieved in 10 seconds at the current acceleration rate. As such its length will be approximately 10 kts long when a 1 kt/sec deceleration rate is being maintained. Given the fact that the aircraft becomes extremely airspeed unstable as the angle of attack is increased, maintaining a constant deceleration rate becomes difficult. Therefore, it is suggested that only loose tracking of the acceleration be attempted while operating at angles of attack greater than approximately 17 degrees to avoid PIOs. In addition, an angle of attack tape display is provided.

Recovery is initiated as soon as the angle of attack reaches 21 degrees. For the non-turning RFLF maneuvers (5010, 5020, and 7070) the pilot's task is to lower the nose and stabilize at approximately 13 degrees angle of attack without encountering any large bank excursions (desired performance is bank angles less than ±5.0 degrees, adequate is ±10 degrees). The turning RFLF maneuvers (5040, 5050, and 7080) require the pilot to level the wings since these maneuvers involve a 30 degree bank angle entry. Bank angle performance limits for the turning RFLF maneuvers apply to the recovered bank angle (i.e. wings level) and are the same as the non-turning RFLF maneuvers. No bank angle overshoots are allowed for the recovery to the wings-level condition. In addition, pilot comments regarding the aircraft's perceived recovery capability are highly encouraged.

Failure Tasks

All of the failure tasks that will be evaluated during this assessment of the Reference H configuration will be no worse than Hazard Class II (i.e. all will be controllable and non-catastrophic). Failures will be inserted into several of the standard takeoff, landing, and cruise flight cards and will use the same metrics as the base tasks from which they are derived. Failures will be evaluated in a separate block and the pilot will know what type of failure to expect and when it will occur. The purpose of evaluating these failures will be to assess whether a minimum of Level II handling qualities can be maintained despite problems with the flight control system and/or flight controls and not the pilot's ability to respond to an emergency situation.

Tasks 7211 and 7212 (see Appendix B) are based on the Standard Acoustic Takeoff task (2010) with a flaperon hardover and elevator hardover (30° trailing-edge down) respectively. The flaperon hardover (trailing-edge flaps 1 and 8 deflected 30° asymmetrically) (see figure 1) occurs after rotation but prior to liftoff. The elevator hardover occurs at 100 ft AGL and requires the pilot to request that the leading- and trailing-edge flaps to be reconfigured in order to maintain a positive rate-of-climb. The pilot-not-flying will reconfigure the flaps to zero deflection.

Five failures will be evaluated during precision landings. All of the failures, except task 7254, will occur at 300 ft AGL while on short final. Task 7252, an elevator hardover (30° trailing-edge down), does require that the pilot request that the leading- and trailing-edge flaps be reconfigured. The pilot-not-flying will reconfigure the flaps to the TOGA settings. Two of the tasks involve rudder hardovers: task 7253 (rudder panel 1 30° hardover) occurs at 300 ft AGL; task 7254 (all rudder panels 30° hardover) occurs at main gear touchdown. The later task requires the nose wheel to be on the ground in order to maintain positive directional control. The final two precision landing tasks occur with a 15 knot crosswind. Task 7291 reduces the travel of trailing-edge flaps 1, 2, 3, 6, 7, and 8 to between 15° and 30° (a 75% loss of roll control). Task 7292 is a hardover of trailing-edge flaps 2 and 7 (30° asymmetric). As with the basic crosswind landing tasks there will be two different decrab procedures that can be used for these evaluations.

Failures at supersonic cruise conditions will also be evaluated. Using the 2-axis upset as the base task (task 6060), both an elevator hardover (30° trailing-edge up) and a 30° asymmetric hardover of trailing-edge flaps 3 and 6 will be examined. These are tasks 7261 and 7262 respectively. These tasks will be evaluated with an engine complexity of 5 (i.e. the engines can unstart) and with unstart envelope guidance.

Finally, a go-around with trailing-edge flaps jammed at landing deflections (task 7286), a landing starting outside the outer marker without stability augmentation in all axes (task 7100), and a landing starting outside the outer marker with the stabilizer jammed at 0° (task 4110) will be evaluated. These last two task were initially evaluated during the previous Reference H assessment. The tasks themselves have not changed but the aerodynamics, metrics, and reference speeds have been updated for this evaluation.

Flight card description

The typical flight test card includes task definition, including flight phase, Mission Task Element (MTE), weather, failure, and loading conditions, initial conditions for the run, target airspeeds, etc. A narrative procedure for performing the evaluation of each task is provided. Up to three different evaluations are desired for each task; these evaluation segments are described on the flight card along with performance standards. Finally, a space is provided for written comments noted by the PNF for each task. Appendix B contains a copy of the flight cards to be tested. Table 1 summarizes the task list of all flight cards.

Data collection

Pilot experience

Each evaluation pilot is requested to provide a brief biography of flight experience for inclusion in any reporting of results.

Pilot ratings

The familiar Cooper-Harper rating (CHR) scale will be utilized for most LaRC.1 tasks. Copies of the Cooper-Harper ratings chart will be available in the cockpit and are available on request.

Audiovisual records

In addition to the CHR ratings, evaluation pilots are encouraged to provide narrative comments both while performing the tasks and at the conclusion of each evaluation. Both the out-the-window/HUD image and pilot comments will be recorded for post-test analysis and transcription.

Data records

A digital record of selected simulation parameters will be made for each run. Data collection will be at least 4 Hz and will be 8 Hz for most runs. Some of these parameters are analyzed on-the-fly during the run and selected information concerning maximum deviation from target values will be available on the pilot score card display.

Strip charts

24 channels of certain parameters will be recorded on traditional strip chart machines as back up to the data records.

Test Protocol

Test schedule

Simulation sessions are arranged so two pilots can be accommodated over the course of a week. It is expected that the two pilots will alternate sessions, so a two-hour-on, two-hour-off work schedule will be used. Each pilot will be briefed prior to the simulation session to make the session more efficient.

The actual number of simulation sessions required to evaluate the full test matrix will depend upon the pace most comfortable to the evaluation pilot. Barring unforeseen hardware problems, there should be ample time to look at the 40 or so higher-priority tasks during the course of a single week.

Daily schedule:

7:30 - 7:45	Sim team briefing
7:45 - 8:00	Pilot briefing
8:00 - 10:00	1st session - pilot A
10:00 - 12:00	2nd session - pilot B
12:00 - 13:00	Lunch
13:00 - 15:00	3rd session - pilot A
15:00 - 17:00	4th session - pilot B

Motion base operation

The operation of the VMS motion platform will be under the supervision of Simulation Systems Branch (SSB) personnel. They will brief each participant on motion base safety and contingency plans prior to the first motion session. Each participant will be required to complete a health questionnaire and indicate that they have received this briefing prior to the initial motion session.

A key interlock is used in the cockpit to indicate the occupants are all ready to begin motion operations.

Cockpit responsibilities

The PNF will be responsible for preparing the cockpit for each particular MTE and operating the landing gear switch. The PNF will record pilot comments in summary form on each flight card as well as any CHRs provided by the evaluation pilot. The PNF will record the run number, date, and pilot on each flight card and annotate the voice record with the same information at the beginning of each run. The PNF will be provided with a microcassette recorder and encouraged to record the evaluation pilot's comments at the end of each series of runs as a backup to the voice record. The PNF will serve as the communicator to the simulation operations console and test conductor, located in the real-time flight simulation facility control room, and will control the operation of the simulation by calling for "hold", allowing the motion platform to reach initial conditions, and then "operate" to begin each task. The PNF will call for "reset" at the completion of each task.

The evaluation pilot (Pilot Flying) will be tasked with performing each task as outlined in the flight cards and render pilot ratings and other evaluation comments as appropriate. The evaluation pilot will also be responsible for ensuring all motion cockpit occupants are ready to begin motion operations and turning the keylock to allow motion system to activate.

Console responsibilities

The Real-Time Console operator will configure the simulation for each task and introduce appropriate failures and weather states as required for the task under the direction of the test conductor.

Test Conductor

The Test Conductor, located in the control room, will track the progression through the test matrix, maintain the run log, and operate the audio-visual recording devices. The Test Conductor will assure the various tapes and strip charts are labeled with date, pilot, and run numbers.

Bibliography

1. Dornfield, G. M., et. al. "High Speed Civil Transport Reference H - Cycle 2B Simulation Data Base", Contract NAS1-20220, Task Assignment No. &, WBS 4.3.5.2, July 1995

2. Churchill, Brett, et. al. "High Speed Civil Transport Reference H - Cycle 3 Simulation Data Base", Contract NAS1-20220, Task Assignment No. 36, WBS 4.3.5.1.2.1, June 1996

TABLE I. TASK LIST AND EXPERIMENT CROSS-REFERENCE

Card No.	Seq. No.	Task ID	Flight Card Name	Aero-elastic Modes	Motion Cueing	Used in Previous Experiment LaRC.0	TIFS.1	Ames.1	Ames.2
Block 1 - Takeoffs and Stalls									
Famililarization									
1	1	2010	Standard acoustic takeoff	Off	On	√			
2	2	4020	Nominal Approach & Landing	Off	On	√			
Takeoff									
3	1	2010	Standard acoustic takeoff	Off	On			√	√
4	2	2011	Standard acoustic takeoff	Off	On	√			
5	3	2030	Acoustic (Prog Lapse Rate) takeoff	Off	On	√			
6	4	1050	Refused Takeoff	Off	On	√			
7	5	1052	Refused Takeoff - 35 kt x-wind	Off	On	√			
8	6	7035	One Engine Out Takeoff	Off	On	√			
9	7	7036	One Engine Out Takeoff - 35 kt x-wind	Off	On				
10	8	7030	VMCG	Off	On	√			
Recovery from Low-Speed Flight									
11	9	5020	Stall at Max Takeoff Power	Off	On	√			
12	10	5010	Stall at Idle Power	Off	On	√			
13	11	5040	Turning Stall at Idle Power	Off	On	√			√
14	12	5050	Turning Stall at Thrust for Level Flight	Off	On	√			
15	13	7070	Engine-out Stall	Off	On	√			
16	14	7080	Engine-out Turning Stall	Off	On	√			
Block 2 - Approach, Landing, Go-Around									
17	1	4020	Nominal Approach & Landing	Off	On	√		√	
18	2	4020	Nominal Approach & Landing (ASE on)	**On**	On	√			
19	3	7095	Manual Throttle Landing	Off	On	√			
20	4	4220	Decelerating Approach	Off	On				
21	5	4225	Decelerating Approach/ Manual Throttles	Off	On				
22	6	4069	IAG (TIFS) Approach	Off	On		√	√	√
23	7	4093	Crosswind Landing - 25 kt (Procedure A)	Off	On	√		√	√
24	8	4093	Crosswind Landing - 25 kt (Procedure B)	Off	On	√		√	√
25	9	4095	Crosswind Landing - 35 kt	Off	On	√		√	
26	10	4086	Go-Around, 50 ft	Off	On			√	
27	11	4086	Go-Around, 50 ft (ASE On)	**On**	On				
28	12	4085	Go-Around, 30 ft (TS Off)	Off	On	√		√	
29	13	4085	Go-Around, 30 ft (TS On)	Off	On	√			
30	14	4140	VFR Circling Approach	Off	On				
31	15	7050	Dynamic VMCL-2	Off	On	√			
Block 3 - Operation after Upsets									
32	1	7060	Engine Unstart	Off	On	√			
33	2	7060	Engine Unstart (ASE ON)	Off	On	√			
34	3	6050	Inadvertent Speed Increase, high speed	Off	On	√			
35	4	6060	Simulated 2-axis Gust Upset, high speed	Off	On	√			
36	5	7040	Dynamic VMCA	Off	On	√			
37	6	5070	Emergency Descent	Off	**Off**	√			
38	7	5060	Diving Pull-out	Off	**Off**	√			

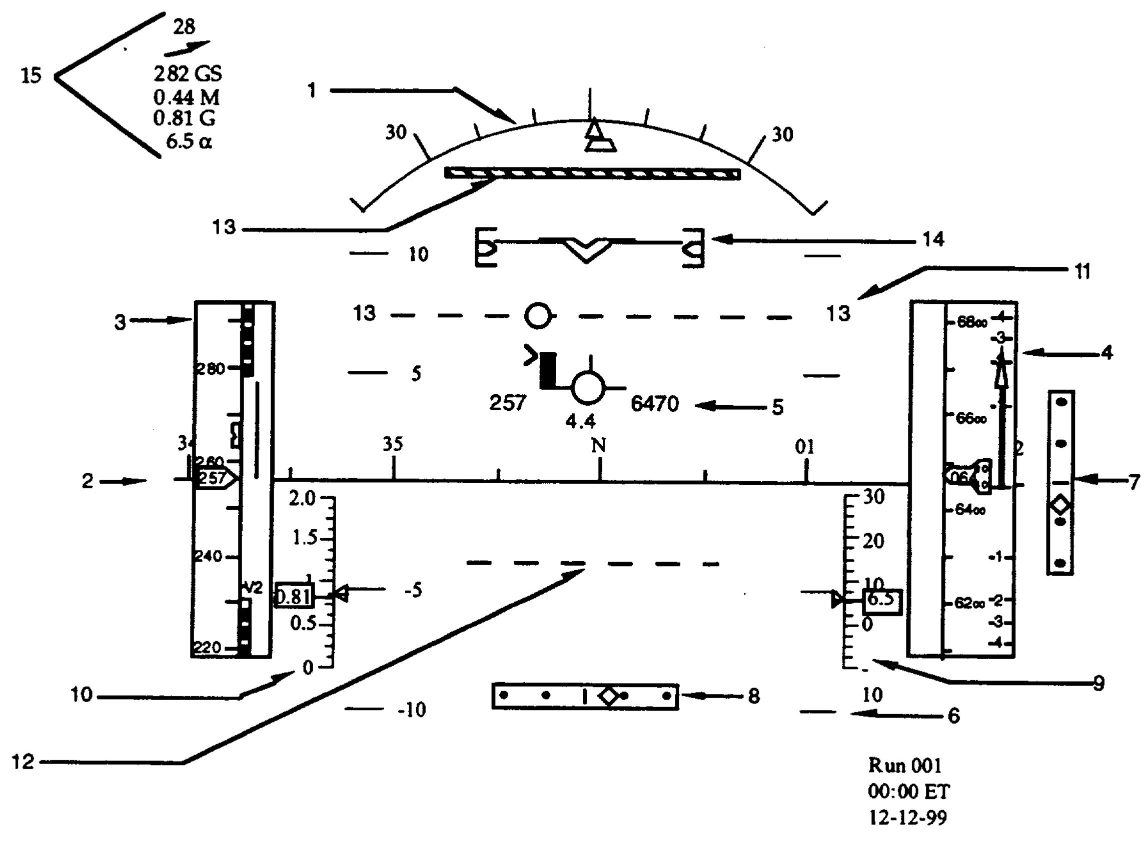
TABLE I. TASK LIST AND EXPERIMENT CROSS-REFERENCE (CONT'D)

Card No.	Seq. No.	Task ID	Flight Card Name	Aero-elastic Modes	Motion Cueing	Used in Previous Experiment LaRC.0	TIFS.1	Ames.1	Ames.2
Block 4 - Climb, Cruise, Descent									
39	1	3020	Climb Trans. to Level Flight - Transonic	Off	On	√			
40	2	3022	Climb Trans. to Level Flight - Supersonic	Off	On	√			
41	3	3040	Level Flight Trans. to Climb	Off	On	√			
42	4	3050	Profile Descent	Off	On	√			
43	5	3060	Level Flight Trans. to Descent - Supersonic	Off	On	√			
44	6	3062	Level Flight Trans. to Descent - Transonic	Off	On	√			
45	7	3070	Transonic Accel	Off	On	√			
46	8	3072	Supersonic Accel	Off	On	√			
47	9	3074	Transonic Decel	Off	On	√			
48	10	3076	Subsonic Decel	Off	On	√			
49	11	3080	Heading Change - Transonic Climb	Off	On	√			
50	12	3082	Heading Change - Initial Cruise	Off	On	√			
51	13	3084	Heading Change - Final Cruise	Off	On	√			
52	14	3086	Heading Change - Transonic Descent	Off	On	√			
53	15	3088	Heading Change - TCA Descent	Off	On	√			
54	16	3030	Profile Climb	Off	On	√			
Block 5 - Failures									
55	4	7211	Flaperon Hardover during takeoff	Off	On				
56	1	7212	Elevator Hardover (TE down) during takeoff	Off	On				
57	2	7252	Elevator Hardover (TE down) during landing	Off	On				
58	8	7253	Rudder Hardover during landing	Off	On				
59	9	7254	Rudder Hardover during landing rollout	Off	On				
60	5	7291	Loss of 75% Roll Control during landing w/X-wind	Off	On				
61	6	7292	Flaperon Hardover during landing w/X-wind	Off	On				
62	3	7261	Elevator Hardover (TE up) during 2-axis upset	Off	On				
63	7	7262	Flaperon Hardover during 2-axis upset	Off	On				
64	10	7286	Go-around with Autoflap failure	Off	On				
65	12	4110	Landing with Jammed Stabilizer	Off	On	√			
66	11	7100	Unaugmented Landing	Off	On	√			

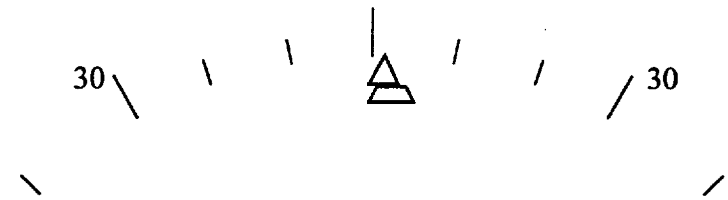
Appendix A. HUD symbology

The Head Up Display (HUD) format shown below is referred to as the LaRC.1 HUD. The format shown below has all elements depicted; this "full clutter mode" is not used in any of the tasks of LaRC.1, but various elements can be enabled for specific tasks. This symbology set has been made to follow as closely as possible the symbology set discussed at an XVS symbology workshop at Langley in September 1996; but does not completely conform to the XVS symbology set due to resource limitations.

The various features of the HUD are indicated by their identification numbers (from 1 to 15) and are described in sequence below. Operation of the new HUD element logic is also discussed.

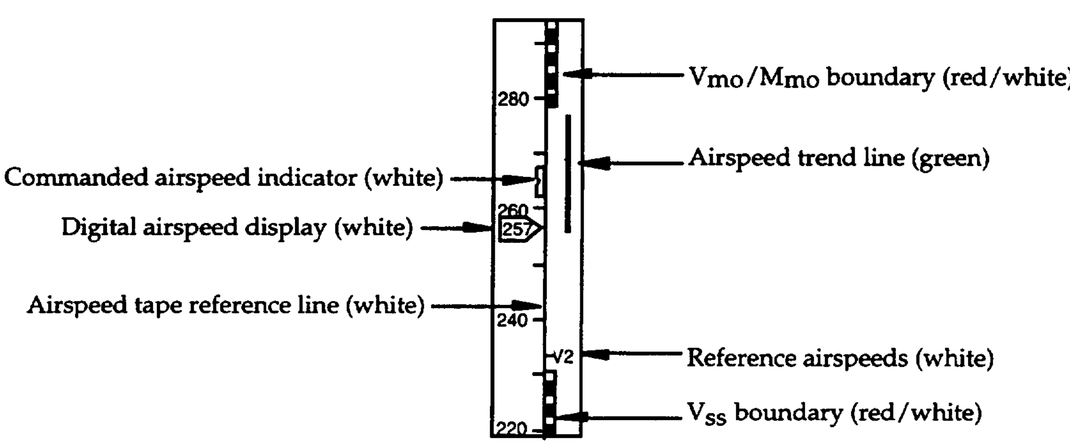


1 *Bank angle scale with roll pointer and side-slip indicator.* This section of the LaRC.1 HUD is specified to be the same as previously employed for the 1995 LaRC.0 assessment study. It should be noted that after initial evaluations during LaRC.0, the side-slip indicator (lower portion of roll pointer triangle) displays complementary filtered side-slip angle as the default for all tasks. The side-slip indicator will turn amber when it moves just past the edge of the roll pointer indicating a sideslip angle of 4 degrees.

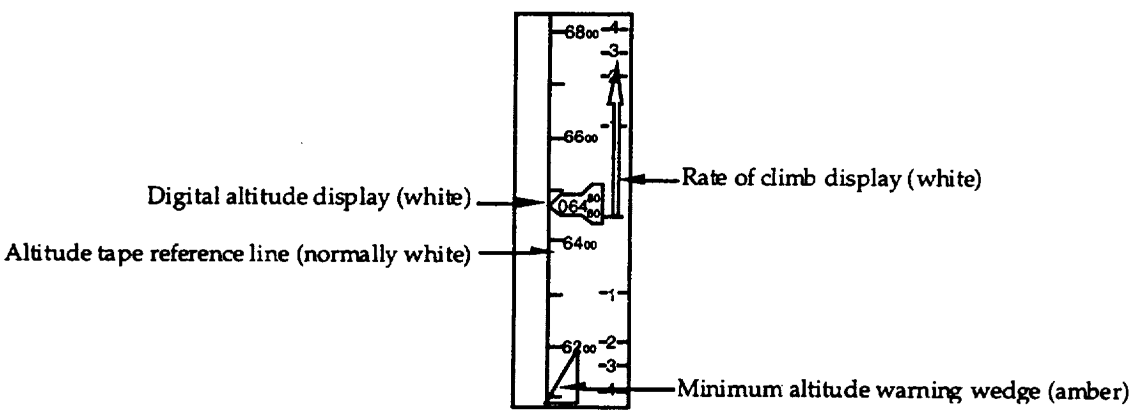


2 *Heading scale/horizon line.* This section of the LaRC.1 HUD is specified to be the same as previously employed for LaRC.0. Smaller tick-marks, without labels, are drawn at 5 degree increments.

3 *Airspeed tape display.* Item #3 is a totally new element for the NASA LaRC Ref.-H assessment project. It displays analog and digital un-filtered equivalent airspeed (EAS) as currently displayed only digitally on the 1995 LaRC.0 HUD. Several airspeed "bugs" are required for this system. Takeoff decision speed V_1, rotation speed V_r, takeoff safety speed V_2, and V_{mo}, M_{mo}, maximum operating speed, are displayed. V_{mo}/M_{mo} and V_{min} boundaries are indicated by red and white checkered areas on the right side of the airspeed tape reference line. Values V_1, V_r, V_2, V_{mo}, M_{mo}, and V_{min} are read from the maneuver initial condition (I.C.) files. V-speeds are displayed on the right side of airspeed tape reference line (white). Current commanded airspeed, either from the I.C. file or from the CDU, are displayed by the appropriate icon shown below on the left of the airspeed tape line (white). Digital equivalent airspeed is displayed in the high-lighted area to the nearest knot (white). The airspeed trend line (green) indicates the anticipated airspeed which will exist in 10 seconds. It emanates from the origin of the airspeed tape. The inertial acceleration parameter from the airspeed complementary filter system is used for this purpose. A 1.0 second time lag is applied to this variable to smooth its response. The open areas of the airspeed indicator are not shaded.

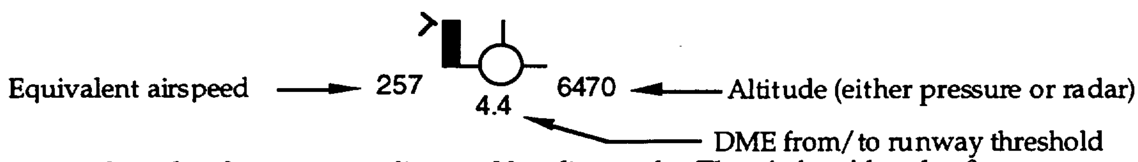


4. *Altitude display tape.* The altitude tape display is also a new HUD element. It's function is to provide detailed altitude information to the pilot. The digital altitude display (white) is different from the airspeed digital display in that the hundreds of feet digits scroll at a different rate than the tens of feet digits. For example, for altitudes between 6,500 and 6,600 the 065 would remain constant and the tens of feet digits would change. Note that the tens of feet digits are resolved in 20 foot increments. The color of the altitude tape reference line, tick marks, and labels are white unless the altitude is below the minimum altitude. When the altitude is below the minimum altitude, the altitude tick marks are amber. Minimum altitude is set to 200 feet AGL. The rate of climb display (white) indicates the analog rate of climb only when the rate of climb is between ±4,000 feet per minute (fpm). When the rate of climb is greater than ±4,000 fpm, the rate of climb will be displayed by three digits (white) at the top (or bottom) of the scale indicating rate of climb in hundreds of feet per minute. The scaling of this display is non-linear in that the distance from 0 to 1,000 fpm is twice that between 1,000 and 2,000 fpm, which is twice the distance between 2,000 and 3,000 fpm. The distance between 3,000 fpm and 4,000 fpm is the same as 2,000 fpm to 3,000 fpm. The minimum altitude wedge (amber) will become visible when the altitude reaches the minimum altitude (200 feet) with the base of the wedge touching the altitude scale line when the altitude reaches 0 ft. There is an option to switch between pressure altitude and radar (landing gear) altitude. When in radar altitude mode, an R (white) is displayed at the top and bottom of the altitude scale line. No indication is shown when not in radar altitude mode (i.e. a P is not displayed when not in radar mode in an attempt to reduce HUD clutter). The open areas of the altitude indicator are not shaded.

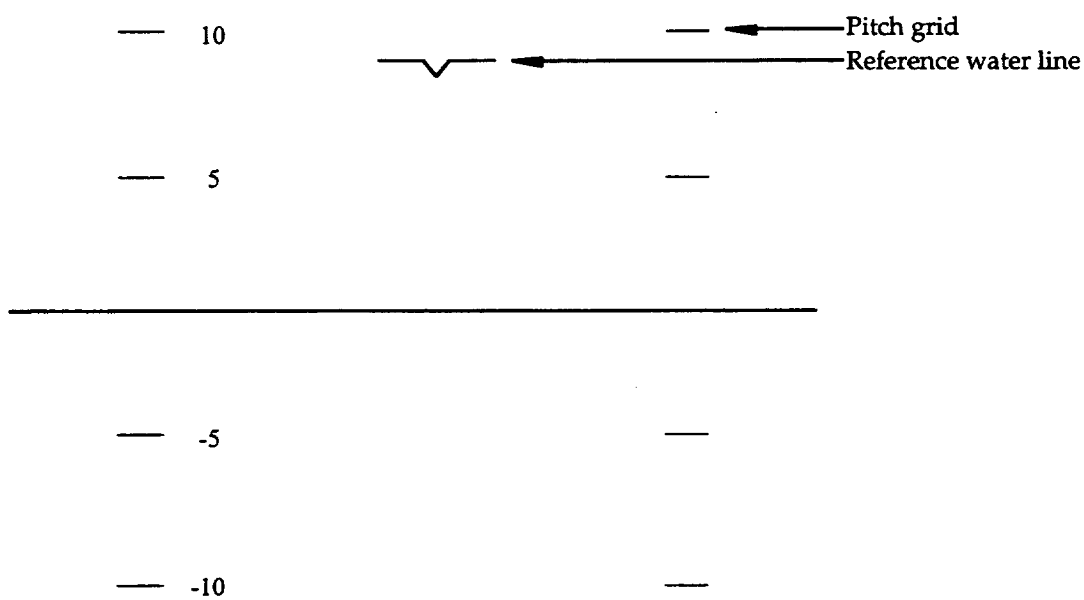


5. *Velocity vector cluster.* The velocity vector cluster (white) is similar to what was used in the 1995 LaRC.0 HUD, and includes the velocity vector symbol (an open circle with fins), option digital airspeed, altitude, and DME readouts, an airspeed error tape that grows above or below the left fin of the velocity vector symbol, and an acceleration indicator. The main difference is that the digital airspeed and altitude indicators of the 1995 LARC.0 HUD can be moved to the airspeed and altitude display tapes. DME distance from/to the runway threshold can also be displayed if desired. Other minor changes are the acceleration diamond is now a caret (>) and it is driven differently. The acceleration caret indications are now dependent on inertial acceleration which is computed in the airspeed complementary filter section. This computation employs the acceleration of the aircraft's C.G. resolved along the flight path. A 1 second lag is applied to this signal to improve its motion. In addition, the capability to automatically move the acceleration indicator from the velocity vector cluster up to the pitch reference waterline has been implemented. It will move up to the reference water line when the angle of attack is above 15 degrees and back to the velocity vector cluster when the angle of attack is below 14 degrees. This was done to enhance its use

during high angle of attack operations. Another feature of the acceleration arrow is that its zero position can be biased to permit its use while maintaining a non-zero acceleration, such as is desired for the entry phase of the recovery from limit flight tasks. During these tasks (maneuvers 5010, 5020, 5040, 5050, 7070, and 7080) a 1 kt/sec deceleration rate will result when the acceleration arrow is aligned with the left inlet of the velocity vector. A 1 kt/sec acceleration will move the acceleration arrow 1 degree on the HUD.

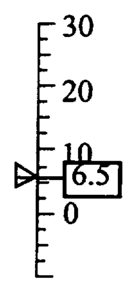


6. *Pitch grid, reference water line, and heading scale.* The pitch grid and reference water line (white) are changed for the 1996 LARC.0 HUD. The water line is replaced with a winged-V. Use of the 1995 LARC.0 HUD takeoff rotation brackets (magenta) and expanded reference water line (item #13) are included in the HUD option. The pitch grid is much wider than the 1995 LARC.0 HUD and has the center open. Only one set of pitch grid labels are indicated for this HUD option and are placed inside of the left side pitch grid tick marks. The Horizon line and heading scale is the same as the 1995 LARC.0 HUD. The tail-scrape bar (red/white), which is item #14, is also retained with this HUD option.

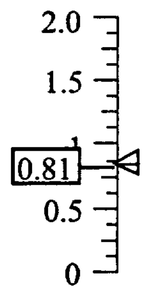


7,8. *ILS glideslope and localizer displays.* The ILS glideslope and localizer displays are colored white with a white moving diamond. When excessive deviation occurs, the white diamond changes to an amber flashing diamond. Excessive deviation is one dot. The glideslope display is placed just outside of the altitude display tape.

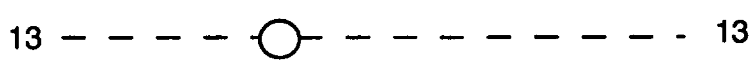
9) The analog/digital angle of attack display (white) is defined below. Digital angle of attack moves with the analog pointer on the scale. If the angle of attack is not displayed using this display, digital angle of attack is displayed in the upper left hand corner of the HUD.



10) The analog/digital "g" tape (white) display is defined below. Digital normal acceleration moves with the analog pointer on the scale. If the normal acceleration is not displayed using this display, digital normal acceleration is displayed in the upper left hand corner of the HUD.



11) The Takeoff Climb Guidance System is shown below. It consists of a labeled dashed line with a velocity vector guidance symbol (an open circle). The dashed line (magenta) is displayed when the pilot is commanded to fly a specific climb gradient (maneuvers 2010 and 2030). The labels of this line represent the climb gradient, in percent. When the velocity vector guidance system is operating in this mode, the velocity vector guidance symbol (also magenta) is constrained to travel across the dashed line and provides the pilot with steering information only to maintain the extended runway centerline. When the takeoff guidance system is in airspeed command mode (maneuvers 2011, 7035, and 7036) the dashed line is removed and the velocity vector guidance symbol provides both longitudinal and lateral information. Longitudinal guidance is a combination of airspeed error and inertial acceleration and is provided to assist the pilot to maintain the desired airspeed when operating in a fixed-thrust mode. The pilot attempts to place the velocity vector symbol on top of the velocity vector guidance symbol. The lateral guidance is the same regardless of which mode of the takeoff climb guidance system is selected.

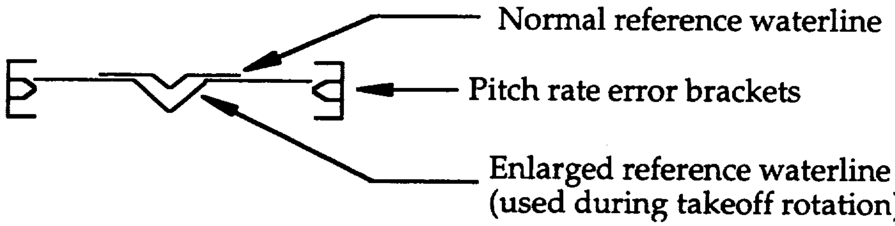


12) The depressed glideslope reference line is shown below (white). Its purpose is to provide the pilot with an indication of where to place the velocity vector to fly a flight path angle equal to the glideslope. It is horizontally slaved to the velocity vector.

13) The tail scrape bar (red and white) is shown below. It indicates what pitch attitude the aircraft would have to reach in order to scrape the tail on the ground.

14) Reference waterline (white) is shown below in two sizes. Most of the time the reference waterline is the smaller size which is indicated by the "normal reference waterline" label. During takeoff rotations, however, the reference waterline becomes much larger and is used in conjunction with the pitch rate error brackets to precisely control the aircraft's rotation performance. The pitch rate error brackets are approximately 2 HUD degrees high. A pitch rate error of ±0.5 deg/sec will displace the pitch rate error bracket one half the height of the inner pointer with respect to the refer-

ence waterline. A pitch rate error of ±1.0 deg/sec will displace the pitch rate error bracket one half of its total height with respect to the reference waterline.



15) The digital information which can be displayed in the upper left hand corner of the HUD is shown below. When angle of attack and normal acceleration are being displayed using the analog/digital tape displays, those parameters are removed from this element.

28 ← Wind indicator (speed and relative direction)
282 GS ← Ground speed (kts)
0.44 M ← Mach number
0.81 G ← Normal acceleration (g)
6.5 α ← Angle of attack (degs)

<u>HUD display control:</u> Display of all of the HUD items listed below are controlled through the I.C. files for each of the assessment tasks. Each task has several HUD options that can be viewed by striking the HUD declutter button on the simulator instrument panel. In general, three HUD options are available along with varying levels of declutter. Repeatedly striking the declutter button will eventually remove all HUD symbology. Additionally, HUD mode changes, such as encountered during the go-around maneuver, will induce an automatic HUD change when the pilot strikes the TOGA button.

Appendix B. Flight cards

The following pages represent the flight cards used in the Ref. H Assessment test.

Flight Card Nomenclature

AGL	Above Ground Level, ft
ALT	Altitude
AOA	Angle of attack, degrees
A/T	Autothrottle
CDU	Cockpit Display Unit
C.G.	Center of gravity, % of mean aerodynamic chord
CHR	Cooper-Harper pilot rating
Config	Aircraft configuration
DME	Distance Measuring Equipment (shorthand for distance from runway threshold)
EPR	Exhaust Pressure Ratio (shorthand for throttle position)
F/D	Flight Director
FPM, fpm	Feet per minute
GEAR	Landing gear position
G/S	Glide slope (part of the instrument landing system)
GW	Gross weight
HUD	Head-up display
ILS	Instrument Landing System
KEAS	Equivalent airspeed, knots
LEF	Leading edge flaps, degrees
LOC	Localizer (part of the instrument landing system)
M	Mach Number
M13	Mass case 13 - maximum taxi weight at forward C.G.
MCT	Maximum continuous thrust
MFC	Final Cruise mass condition
MIC	Initial Cruise mass condition
Mmo	Maximum Operating Mach Number
MTE	Mission Task Element
MTO	Maximum Takeoff power setting
N/A	Not applicable
OM	Outer Marker
PFD	Primary Flight Display
PSCAS	Pitch Stability and Control Augmentation System
PIO	Pilot-Induced Oscillation
R/C	Rate of climb, ft/min
RSCAS	Roll Stability and Control Augmentation System
TEF	Trailing edge flaps, degrees
TO/GA	Takeoff/Go-Around
Trim	Indicates this parameter should be set to the value required to achieve trimmed (unaccelerated) initial conditions.
V1	Takeoff Decision Speed
V2	Takeoff Safety Speed
Vapp	Approach Speed
Vapp1	Approach Speed, first approach segment

Vapp2	Approach Speed, second approach segment
VFR	Visual Flight Rules
Vg/a	Go-Around Speed
VHD	Velocity/Height Display
VLO, Vlo	Lift-off Speed
Vmin	Minimum Operating Speed
Vmo	Maximum Operating Speed
Vmca	Minimum Control Speed, air
Vmcg	Minimum Control Speed, ground
Vmcl-2	Minimum Control Speed, landing, two engines out
Vr	Takeoff Rotation Speed
Vref	Reference Speed
V/S	Vertical speed

1050 Refused Takeoff

Flight Phase	MTE	Weather State	Failures
2A. Takeoff	5. Rejected Takeoff	1. Light Turb.	0. No Failures
Loading: 3. M13 - Max Taxi Weight @ fwd C.G., full aft fuselage fuel, partial wing fuel, max payload			

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Light/ None	0	Unlimited/ Unlimited	Dry, grooved	End of Rwy, on centerline

ALT	Field	V1	170	PSCAS	NORMAL
KEAS/M	0	Vr	186	RSCAS	NORMAL
GW	649,914	VLO	200	A/T	OFF
C.G.	48.1	V2	202	HUD	ON
GEAR	DOWN	V2+10	212	F/D	OFF
LEF/TEF	30/10	Vmin	181	Config	*Ref H Cyc 3*

Abnormals/Exceptions:
None.

Procedure–Evaluation Pilot (PF):
1. Set brakes.
2. Advance throttles to takeoff EPR.
3. Release the brakes and maintain centerline during ground roll. PNF will make airspeed call-outs and monitor engine performance.
4. When PNF calls "Abort" immediately retard throttles to idle and apply maximum braking. Maintain runway centerline.
5. Terminate the maneuver when the aircraft is stopped.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.
2. Make airspeed callout at 100 knots.
3. Immediately before reaching V1, call "Engine # Failed, Abort".

Date: ____________ **Pilot:** ______________________ **Runs:** ____________

Evaluation Segment: Runway Centerline Tracking - RTO	Long CHR	Lat / Dir CHR
Start Evaluation: Stopped on Runway End Evaluation: Wheel stop	N/A	

Evaluation Basis: The pilot is to evaluate the ease of tracking the runway centerline with rudder pedals alone as the aircraft accelerates during the takeoff roll and the deceleration during the RTO.

Performance Standards	Target	Desired	Adequate
Runway Centerline Deviation (ft)	0	±10	±27

Refused Takeoff

Flight Phase	MTE	Weather State	Failures
2A. Takeoff	5. Rejected Takeoff	33. 35 Kt Crosswind	0. No Failures
Loading: 3. M13 - Max Taxi Weight @ fwd C.G., full aft fuselage fuel, partial wing fuel, max payload			

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 35 Kt	Light/ None	0	Unlimited/ Unlimited	Dry, grooved	End of Rwy, on centerline

ALT	Field	V1	170	PSCAS	NORMAL
KEAS/M	0	Vr	186	RSCAS	NORMAL
GW	649,914	VLO	200	A/T	OFF
C.G.	48.1	V2	202	HUD	ON
GEAR	DOWN	V2+10	212	F/D	OFF
LEF/TEF	30/10	Vmin	181	Config	*Ref H Cyc 3*

Abnormals/Exceptions:
None.

Procedure-Evaluation Pilot (PF):
1. Set brakes.
2. Advance throttles to takeoff EPR.
3. Release the brakes and maintain centerline during ground roll. PNF will make airspeed call-outs and monitor engine performance.
4. When PNF calls "Abort" immediately retard throttles to idle and apply maximum braking. Maintain runway centerline.
5. Terminate the maneuver when the aircraft is stopped.

Procedure-Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.
2. Make airspeed callout at 100 knots.
3. Immediately before reaching V1, call "Engine # Failed, Abort".

Date: ____________ **Pilot:** ______________________ **Runs:** __________

Evaluation Segment: Runway Centerline Tracking - RTO	Long CHR	Lat / Dir CHR
Start Evaluation: Stopped on Runway End Evaluation: Wheel stop	N/A	

Evaluation Basis: The pilot is to evaluate the ease of tracking the runway centerline with rudder pedals alone as the aircraft accelerates during the takeoff roll and the deceleration during the RTO.

Performance Standards	Target	Desired	Adequate
Runway Centerline Deviation (ft)	0	±10	±27

Standard Acoustic Takeoff

Flight Phase	MTE	Weather State	Failures
2A. Takeoff	100. Standard Acoustic Takeoff	1. Light Turb.	0. No Failures

Loading: 3. M13 - Max Taxi Weight @ fwd C.G., full aft fuselage fuel, partial wing fuel, max payload

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Light/ None	0	Unlimited/ Unlimited	Dry, grooved	End of Runway on Centerline

ALT	Field	V1	170	PSCAS	NORMAL
KEAS/M	0	Vr	186	RSCAS	NORMAL
GW	649,914	VLO	205	A/T	OFF
C.G.	48.1	V2	202	HUD	ON
GEAR	DOWN	V2+10	212	F/D	OFF
LEF/TEF	Auto	Vmin	181	Config	*Ref H Cyc 3*

Abnormals/Exceptions:
None.

Procedure–Evaluation Pilot (PF):
1. Set brakes.
2. Advance throttles to takeoff EPR.
3. Release the brakes and maintain centerline during ground roll. PNF will make airspeed call-outs and monitor engine performance.
4. At rotation speed (Vr), initiate rotation to the rotation pitch attitude (10 deg).
5. At positive climb-rate, call "gear up".
6. Adjust initial flight path to climb out at 8 deg / 14% (airspeed should increase).
7. At 2.8 DME adjust flight path to climb out at 2.5 deg/4.4 %. PNF to engage autothrottles will maintain V2+10.
8. Maintain runway heading throughout the cutback maneuver. G load of 1.0 ±0.3 is acceptable.
9. Terminate maneuver at 8.0 DME.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm takeoff flap and reference speed bugs (Vc=V2+10=212 kts) and initial climb gradient (8 deg/14%) are properly set. High-light the desired initial climb gradient (grad1) and prepare the secondary climb gradient to be used at cutback.
2. Make airspeed call-outs at 100 knots, V1, and Vr.
3. Move gear handle to gear-up position, when requested by PF.
4. At 2.8 DME, call "cutback," change the commanded flight path angle to the secondary climb gradient (2.5 deg/4.4%) and engage autothrottles.

Date: ____________ **Pilot:** ______________________ **Runs:** ____________

Evaluation Segment: Takeoff Roll, Rotation & Initial Climb Out - Acoustic
Start Evaluation: Stopped on Runway
End Evaluation: Just prior to EPR cutback

Long CHR	Lat / Dir CHR

Evaluation Basis: The pilot is to evaluate the ability to track runway centerline, rotate promptly (without tail strike), liftoff, and capture the target climb speed. No PIOs or geometry strikes are allowed.

Performance Standards	Target	Desired	Adequate
Rotation pitch attitude (deg)	10	10±0.5	10±1
Deviation from climb speed (kt)	0	±5	±10
Bank Angle Control (deg)	0	±5	±10
Runway Heading Deviation (deg)	0	±2	±4
Load Factor (g)	1.0±0.2	1.0±0.2	1.0±0.3
Climbout Flight Path Angle (deg)	8	8±0.5	8±1.0

Evaluation Segment: EPR Cutback
Start Evaluation: Initiation of EPR cutback
End Evaluation: Stabilized at V2+10 kt after cutback

Long CHR	Lat / Dir CHR

Evaluation Basis: The pilot is to evaluate the ability to maintain the climb airspeed and desired flight path Also evaluated is the ability to maintain runway heading with minimal roll angle. No PIOs are allowed.

Performance Standards	Target	Desired	Adequate
Deviation from Climb Airspeed (kt)	0	±5	±10
Bank Angle Control (deg)	0	±5	±10
Runway Heading Deviation (deg)	0	±2	±4
Load Factor (g)	1.0±0.2	1.0±0.2	1.0±0.3
Climbout Flight Path Angle (deg)	2.5	2.5±0.5	2.5±1.0

Standard Acoustic Takeoff - alternate procedure

Flight Phase	MTE	Weather State	Failures
2A. Takeoff	100. Standard Acoustic Takeoff	1. Light Turb.	0. No Failures

Loading: 3. M13 - Max Taxi Weight @ fwd C.G., full aft fuselage fuel, partial wing fuel, max payload

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Light/ None	0	Unlimited/ Unlimited	Dry, grooved	End of Runway on Centerline

ALT	Field	V1	170	PSCAS	NORMAL
KEAS/M	0	Vr	186	RSCAS	NORMAL
GW	649,914	VLO	205	A/T	OFF
C.G.	48.1	V2	202	HUD	ON
GEAR	DOWN	V2+10	212	F/D	TO spd mode
LEF/TEF	30/10	Vmin	181	Config	*Ref H Cyc 3*

Abnormals/Exceptions:
None.

Note: This maneuver to be performed with manual thrust and flaps.

Procedure–Evaluation Pilot (PF):

1. Set brakes.
2. Advance throttles to takeoff EPR.
3. Release the brakes and maintain centerline during ground roll. PNF will make airspeed call-outs and monitor engine performance.
4. At rotation speed (Vr), initiate rotation to follow rotation rate pitch guidance indicators. Utilize HUD guidance to preclude tail-strikes.
5. At positive climb-rate, call "gear up". Follow velocity vector guidance symbol to intercept and maintain speed and extended runway centerline.
6. When established at V2+10, PNF takes control of the throttles.
7. Maintain target climb airspeed and runway heading throughout cutback maneuver.
8. Terminate maneuver at 8.0 DME to record data for acoustic calculations.

Procedure–Test Engineer / Pilot Not Flying (PNF):

1. Confirm initial conditions.
2. Make airspeed call-outs at 100 knots, V1, and Vr.
3. Move gear handle to gear-up position, when requested by PF.
4. Monitor gear retraction and automatic device retraction.
5. Make distance call-outs at 2.6 and 2.7 DME. At 2.8 DME, call "cutback" and manually retard throttles to cutback EPR (56%) over an approximately 7 second interval.
6. Maintain cutback condition until 8.0 DME for acoustic calculations.

Date: ______ **Pilot:** ______ **Runs:** ______

Evaluation Segment: Takeoff Roll, Rotation & Initial Climb Out

Start Evaluation: Stopped on Runway
End Evaluation: Just prior to EPR cutback

Long CHR	Lat / Dir CHR

Evaluation Basis: The pilot is to evaluate the ease of tracking the runway centerline with rudder pedals alone as the aircraft accelerates during the takeoff roll. The pilot is to evaluate the control of the rotation and capability to track the pitch rate guidance indicators, and the ability to follow velocity-vector guidance once airborne. No PIO is allowed. No geometry strikes are allowed.

Performance Standards	Target	Desired	Adequate
Runway Centerline Deviation, on ground (ft)	0	±10	±27
Rotation Pitch Rate Contol, on ground (deg)	generated	<±0.5 bracket 90% of time (±0.6 deg/s)	<±1 bracket 90% of time (±1.2 deg/s)
Longitudinal velocity vector control, airborne (de)	generated	<±1 V-vector height 90% of time	<±2 V-vector height 90% of time
Lateral velocity vector control, airborne (deg)	generated	<±1 V-vector width 90% of time	<±2 V-vector width 90% of time
Deviation from climb speed, after Vc intercept (kt)	0	±5	±10
Bank Angle Control, airborne (deg)	0	±5	±10
Runway Heading Deviation, airborne (deg)	0	±2	±4

Evaluation Segment: EPR Cutback - PLR

Start Evaluation: Initiation of second EPR cutback
End Evaluation: 8.0 DME

Long CHR	Lat / Dir CHR

Evaluation Basis: The pilot is to evaluate the ability to maintain the climb airspeed. Also evaluated is the ability to maintain runway heading with minimal roll angle. No PIO is allowed.

Performance Standards	Target	Desired	Adequate
Longitudinal velocity vector control (deg)	generated	<±1 V-vector height 90% of time	<±2 V-vector height 90% of time
Lateral velocity vector control (deg)	generated	<±1 V-vector width 90% of time	<±2 V-vector width 90% of time
Deviation from Climb Airspeed (kt)	0	±5	±10
Bank Angle Control (deg)	0	±5	±10
Runway Heading Deviation (deg)	0	±2	±4

Acoustic (Prog Lapse Rate) takeoff

Flight Phase	MTE	Weather State	Failures
2A. Takeoff	102. Programmed Lapse Rate Takeoff	12. Moderate Turb. w/Gusts	0. No Failures

Loading: 3. M13 - Max Taxi Weight @ fwd C.G., full aft fuselage fuel, partial wing fuel, max payload

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Moderate/ None	0	Unlimited/ Unlimited	Dry, grooved	End of Rwy, on centerline

ALT	Field	V1	170	PSCAS	NORMAL
KEAS/M	0	Vr	186	RSCAS	NORMAL
GW	649,914	VLO	205	A/T	ON
C.G.	48.1	V2	202	HUD	ON
GEAR	DOWN	Vclimb	250	F/D	TO grad. mode
LEF/TEF	Auto	Vmin	181	Config	*Ref H Cyc 3*

Abnormals/Exceptions:
Takeoff EPR (T0): Max; First cutback speed (VCUT1): 187; Delta time first cutback: 7 seconds;First cutback thrust level (T1): 75%

Procedure–Evaluation Pilot (PF):
1. Engage autothrottle, verify initial and secondary climb gradients (grad1, grad2), and confirm proper EPR (as set by the autothrottle system) and flap position (as set by the autoflap system).
2. Release the brakes and maintain centerline during ground roll.
3. At rotation speed (Vr), initiate rotation to follow rotation rate pitch guidance indicators. Utilize HUD guidance to preclude tail-strikes.
4. At positive climb-rate, call "gear-up".
5. Maneuver the aircraft to follow velocity vector guidance to maintain the extended runway centerline and desired climb gradient.
6. At approximately 3.0 DME and 250 kts, intercept and maintain secondary target climb gradient (if different than the initial climb gradient).

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Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.
2. Make airspeed call-outs at 100 knots, V1, and Vr.
3. Raise landing gear upon PF call.
4. Monitor progress of first automatic thrust reduction to first cutback thrust level (T1).
5. Once first thrust reduction is complete call out "T1 thrust".
6. At approximately 3.0 DME and 250 knots, monitor the autothrottle system transition to airspeed hold mode as it completes the second thrust cutback.
7. Continue the maneuver to at least 8.0 DME to record sufficient data for acoustic calculations.

Date: ____________ **Pilot:** ____________________ **Runs:** ____________

Evaluation Segment: Takeoff Roll, Rotation & Initial Climb Out - PLR
Start Evaluation: Stopped on Runway
End Evaluation: Just prior to second EPR cutback

Long CHR	Lat / Dir CHR

Evaluation Basis: The pilot is to evaluate the ease of tracking the runway centerline with rudder pedals alone as the aircraft accelerates during the takeoff roll. The pilot is to evaluate the control of the rotation and capability to track the pitch rate guidance indicators, and the ability to follow velocity-vector guidance once airborne. No PIO is allowed. No geometry strikes are allowed.

Performance Standards	Target	Desired	Adequate
Runway Centerline Deviation, on ground (ft)	0	±10	±27
Rotation Pitch Rate Contol, on ground (deg)	generated	<±0.5 bracket 90% of time (±0.6 deg/s)	<±1 bracket 90% of time (±1.2 deg/s)
Longitudinal velocity vector control, airborne (de)	generated	<±1 V-vector height 90% of time	<±2 V-vector height 90% of time
Lateral velocity vector control, airborne (deg)	generated	<±1 V-vector width 90% of time	<±2 V-vector width 90% of time
Bank Angle Control, airborne (deg)	0	±5	±10
Runway Heading Deviation, airborne (deg)	0	±2	±4

Evaluation Segment: EPR Cutback - PLR
Start Evaluation: Initiation of second EPR cutback
End Evaluation: 8.0 DME

Long CHR	Lat / Dir CHR

Evaluation Basis: The pilot is to evaluate the ability to maintain the climb airspeed. Also evaluated is the ability to maintain runway heading with minimal roll angle. No PIO is allowed.

Performance Standards	Target	Desired	Adequate
Longitudinal velocity vector control (deg)	generated	<±1 V-vector height 90% of time	<±2 V-vector height 90% of time
Lateral velocity vector control (deg)	generated	<±1 V-vector width 90% of time	<±2 V-vector width 90% of time
Deviation from Climb Airspeed (kt)	0	±5	±10
Bank Angle Control (deg)	0	±5	±10
Runway Heading Deviation (deg)	0	±2	±4

3020 **Climb Trans. to Level Flight - Transonic**

Flight Phase	MTE	Weather State	Failures
5A. Transonic Climb	201. Transition to Level Flight	1. Light Turb.	0. No Failures

Loading: 3. M13 - Max Taxi Weight @ fwd C.G., full aft fuselage fuel, partial wing fuel, max payload

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Light/ None	0	Unlimited/ Unlimited	Dry, grooved	N/A

ALT	26,000	EPR	100%	PSCAS	NORMAL
KEAS/M	350	R/C	Trim	RSCAS	NORMAL
GW	649,914			A/T	OFF
C.G.	48.1			HUD	ON
GEAR	UP			F/D	OFF
LEF/TEF	Auto			Config	*Ref H Cyc 3*

Abnormals/Exceptions:
Thrust Multiplier set to 1.09

Procedure–Evaluation Pilot (PF):
1. PF establishes constant-heading steady-climb at the noted conditions.
2. Approaching a cardinal altitude (e.g. FL 270), rapidly pitch over and reduce power to attain steady level flight at the specified altitude while maintaining airspeed.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.

Date: ____________ **Pilot:** ______________________ **Runs:** __________

Evaluation Segment: Transition to Level Flight (Sub/Transonic)	Long CHR	Lat / Dir CHR
Start Evaluation: Constant-speed Climb or Descent End Evaluation: Constant-speed Level Flight		

Evaluation Basis: Check ability to maintain airspeed during change in climb rate. Evaluate coupling between airspeed and flight path. Evaluate handling qualities during power of configuration change. The transition shall be smooth and continuous.

Performance Standards	Target	Desired	Adequate
Maximum Overshoot of Target Altitude	0	±100	±150
Deviation in Airspeed/Mach (KEAS)	0	±5/0.01M	±10/0.02M
Deviation in Heading (deg)	0	±2	±5
Deviation in Bank Angle (deg)	0	±2	±5

3020

3022 **Climb Trans. to Level Flight - Supersonic**

Flight Phase	MTE	Weather State	Failures
6C. Supersonic Climb	201. Transition to Level Flight	1. Light Turb.	0. No Failures

Loading: 5. MIC - Initial Cruise condition

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Light/ None	0	Unlimited/ Unlimited	Dry, grooved	N/A

ALT	50,000	EPR	100%	PSCAS	NORMAL
KEAS/M	450	R/C	Trim	RSCAS	NORMAL
GW	614,864			A/T	OFF
C.G.	52.5			HUD	ON
GEAR	UP			F/D	OFF
LEF/TEF	Auto			Config	*Ref H Cyc 3*

Abnormals/Exceptions:
Thrust Multiplier set to 1.09

Procedure–Evaluation Pilot (PF):
1. PF establishes constant-heading steady-climb at the noted conditions.
2. Approaching a cardinal altitude (e.g. FL 510), rapidly pitch over and reduce power to attain steady level flight at the specified altitude while maintaining airspeed.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.

Date: ____________ **Pilot:** ____________________ **Runs:** ____________

Evaluation Segment: Transition to Level Flight (Supersonic)
Start Evaluation: Constant-speed Climb or Descent
End Evaluation: Constant-speed Level Flight

Long CHR	Lat / Dir CHR

Evaluation Basis: Check ability to maintain airspeed during change in climb rate. Evaluate coupling between airspeed and flight path. Evaluate handling qualities during power of configuration change. The transition shall be smooth and continuous.

Performance Standards	Target	Desired	Adequate
Maximum Overshoot of Target Altitude	0	±200	±300
Deviation in Airspeed/Mach (KEAS)	0	±5/0.01M	±10/0.02M
Deviation in Heading (deg)	0	±2	±5
Deviation in Bank Angle (deg)	0	±2	±5

3030

Profile Climb

Flight Phase	MTE	Weather State	Failures
X. Various	210. Profile Climb	0. No Weather	0. No Failures
Loading:	X. Misc. - Weight & CG varies		

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	None/ None	0	Unlimited/ Unlimited	Dry, grooved	End of Rwy, on centerline

ALT	Field	V1	154	PSCAS	NORMAL
KEAS/M	0	Vr	166	RSCAS	NORMAL
GW	Various	VLO	190	A/T	OFF
C.G.	Various	V2	194	HUD	ON
GEAR	DOWN	V2+10	204	F/D	ON
LEF/TEF	Auto	Vmin	155	Config	*Ref H Cyc 3*

Abnormals/Exceptions:
Fuel Burn Enabled; Thrust Multiplier set to 1.09

Procedure–Evaluation Pilot (PF):
1. Set brakes.
2. Advance throttles to takeoff EPR.
3. Release the barkes and maintain centerline during ground roll. PNF will make airspeed call-outs, and monitor engine performance.
4. At rotation speed (Vr), initiate rotation to the lift-off pitch attitude. After liftoff, continue rotation until the target climb airspeed and pitch attitude are captured.
5. At positive climb-rate, call "gear-up".
6. Follow flight director and altitude-velocity display guidance until 2.3 M is reached.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.
2. Make airspeed callouts at 100 knots, V1, and Vr.
3. Move gear handle to gear-up position, when requested by PF.

Date: ________ **Pilot:** ________ **Runs:** ________

Evaluation Segment: Profile Climb
Start Evaluation: Climb Attitude Capture
End Evaluation: 2.3M

Long CHR	Lat / Dir CHR

Evaluation Basis: The pilot is to check the handling qualities in profile climb. Evaluate ease of following desired airspeed and attitude.

Performance Standards	Target	Desired	Adequate
Bank Angle Control (deg)	0	±5	±10
Deviation in heading (deg)	0	±2	±5

3040 **Level Flight Trans. to Climb**

Flight Phase	MTE		Weather State	Failures	
4C. Subsonic Cruise	211. Transition to Climb		1. Light Turb.	0. No Failures	
Loading:	3. M13 - Max Taxi Weight @ fwd C.G., full aft fuselage fuel, partial wing fuel, max payload				
Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Light/ None	0	Unlimited/ Unlimited	Dry, grooved	N/A

ALT	10,000	EPR	Trim	PSCAS	NORMAL
KEAS/M	250	R/C	0	RSCAS	NORMAL
GW	649,914			A/T	OFF
C.G.	48.1			HUD	ON
GEAR	UP			F/D	OFF
LEF/TEF	Auto			Config	*Ref H Cyc 3*

Abnormals/Exceptions:
None.

Procedure–Evaluation Pilot (PF):
1. PF initiates 2000 FPM climb from initial straight & level conditions.
2. PF smoothly applies power to maintain initial airspeed, heading, and wings level while maintaining desired climb rate.
3. Stabilize at 250 KEAS and target climb rate.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.

Date: ____________ **Pilot:** ______________________ **Runs:** ____________

Evaluation Segment: Airspeed Change in Climb/Descent (Subsonic)
Start Evaluation: Steady Flight at Initial Constant Airspeed
End Evaluation: Steady Flight at New Constant Airspeed

Long CHR	Lat / Dir CHR

Evaluation Basis: Check ability to initiate climb during normal operations. Check for undesirable airspeed coupling.

Performance Standards	Target	Desired	Adequate
Deviation in Bank Angle (deg)	0	±2	±5
Deviation in Target Rate of Climb (fpm)	0	±200	±300
Deviation in Heading (deg)	0	±2	±5
Overshoot/Undershoot in Airspeed (KEAS)	0	±10	±20

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3050

Profile Descent

Flight Phase	MTE	Weather State	Failures
X. Various	220. Profile Descent	0. No Weather	0. No Failures
Loading: X. Misc. - Weight & CG varies			

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	None/ None	0	Unlimited/ Unlimited	Dry, grooved	N/A

ALT	64,000	EPR	Trim	PSCAS	NORMAL
KEAS/M	M 2.4	R/C	0	RSCAS	NORMAL
GW	Various			A/T	OFF
C.G.	Various			HUD	ON
GEAR	UP			F/D	OFF
LEF/TEF	Auto			Config	*Ref H Cyc 3*

Abnormals/Exceptions:
None.

Procedure–Evaluation Pilot (PF):
1. PF establishes a normal descent maintaining initial heading and bank angle.
2. Follow Vmo line on velocity-altitude display until reaching final conditions (15,000 ft and 250 KEAS).

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.

Date: ____________ **Pilot:** ______________________ **Runs:** __________

Evaluation Segment: Profile Descent (complete)
Start Evaluation: 64,000 ft
End Evaluation: 15,000 ft, 250 KEAS

Long CHR	Lat / Dir CHR

Evaluation Basis: Evaluate handling qualities of the airplane in descent. Check gust sensitivity in descent.

Performance Standards	Target	Desired	Adequate
Bank Angle Control (deg)	0	±2	±10
Deviation in Scheduled Airspeed (knots)	0	±5	±20
Deviation in Heading (deg)	0	±2	±5

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3060 **Transition to Supersonic Descent**

Flight Phase	MTE	Weather State	Failures
7C. Supersonic Cruise	221. Transition to Descent	1. Light Turb.	0. No Failures

Loading: 7. MFC - Final Cruise condition

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Light/ None	0	Unlimited/ Unlimited	Dry, grooved	N/A

ALT	63,700	EPR	Trim	PSCAS	NORMAL
KEAS/M	M 2.4	R/C	0	RSCAS	NORMAL
GW	384,862			A/T	OFF
C.G.	53.2			HUD	ON
GEAR	UP			F/D	OFF
LEF/TEF	Auto			Config	*Ref H Cyc 3*

Abnormals/Exceptions:
None.

Procedure–Evaluation Pilot (PF):
1. PF establishes straight and level flight at the noted conditions.
2. PF rapidly pitches over to attain a constant descent rate of 1000 fpm while maintaining airspeed.
3. Repeat test for descent rates of 2000 fpm and 4000 fpm.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.

Date: ______ **Pilot:** ______ **Runs:** ______

		Long CHR	Lat / Dir CHR
Evaluation Segment:	Transition to Descent (Supersonic)		
Start Evaluation:	Straight and Level Flight		
End Evaluation:	Stabilized Descent at Constant Mach		

Evaluation Basis: Check ability to maintain Mach during transition to descent. Evaluate coupling between airspeed and flight path. Evaluate handling qualities during power and configuration change. The transition shall be smooth and continuous.

Performance Standards	Target	Desired	Adequate
Maximum Overshoot in Target Descent Rate	0	±200	±300
Deviation in Airspeed/Mach (KEAS)	0	±5/0.01M	±10/0.02M
Deviation in Heading (deg)	0	±2	±4
Deviation in Bank Angle (deg)	0	±2	±5

3062 Transition to Transonic Descent

Flight Phase	MTE	Weather State	Failures
10C. Transonic Cruise	221. Transition to Descent	1. Light Turb.	0. No Failures

Loading: 7. MFC - Final Cruise condition

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Light/ None	0	Unlimited/ Unlimited	Dry, grooved	N/A

ALT	35,000	EPR Trim	Trim 0	PSCAS	NORMAL
KEAS/M	M 0.95			RSCAS	NORMAL
GW	384,862			A/T	OFF
C.G.	53.2			HUD	ON
GEAR	UP			F/D	OFF
LEF/TEF	Auto			Config	*Ref H Cyc 3*

Abnormals/Exceptions:
None.

Procedure–Evaluation Pilot (PF):
1. PF establishes straight and level flight at the noted conditions.
2. PF rapidly pitches over to attain a constant descent rate of 1000 fpm while maintaining airspeed.
3. Repeat test for descent rates of 2000 fpm and 4000 fpm.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.

Date: ____________ **Pilot:** ____________________ **Runs:** ____________

Evaluation Segment: Transition to Descent (Transonic)
Start Evaluation: Straight and Level Flight
End Evaluation: Stabilized Descent at Constant Mach

Long CHR	Lat / Dir CHR

Evaluation Basis: Check ability to maintain Mach during transition to descent. Evaluate coupling between airspeed and flight path. Evaluate handling qualities during power and configuration change. The transition shall be smooth and continuous.

Performance Standards	Target	Desired	Adequate
Maximum Overshoot in Target Descent Rate	0	±200	±400
Deviation in Airspeed/Mach (KEAS)	0	±5/0.01M	±10/0.02M
Deviation in Heading (deg)	0	±2	±4
Deviation in Bank Angle (deg)	0	±2	±5

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3070 **Airspeed Change in Subsonic Climb**

Flight Phase	MTE	Weather State	Failures
4B. Subsonic Climb	230. Airspeed Change	1. Light Turb.	0. No Failures
Loading: 3. MI3 - Max Taxi Weight @ fwd C.G., full aft fuselage fuel, partial wing fuel, max payload			

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Light/ None	0	Unlimited/ Unlimited	Dry, grooved	N/A

ALT	10,000	EPR	Trim	PSCAS	NORMAL
KEAS/M	250	R/C	1000	RSCAS	NORMAL
GW	649,914			A/T	OFF
C.G.	48.1			HUD	ON
GEAR	UP			F/D	OFF
LEF/TEF	Auto			Config	*Ref H Cyc 3*

Abnormals/Exceptions:
None.

Procedure–Evaluation Pilot (PF):
1. PF initiates 1000 FPM climb at the noted conditions.
2. PF smoothly applies power (up to MCT) to accelerate the airplane to 350 KEAS (or to the highest standard airspeed/Mach for the flight condition) while maintaining vertical speed, heading and wings level.
3. Stabilize at 350 KEAS and target climb rate.
4. PF smoothly reduces power to return to initial airpeed, while maintaining climb rate, heading, and bank angle.
5. Thrust may be adjusted to assist in the smooth performance of this maneuver.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.

Date: ____________ **Pilot:** ______________________ **Runs:** ____________

Evaluation Segment: Airspeed Change in Climb/Descent (Subsonic)	Long CHR	Lat / Dir CHR
Start Evaluation: Steady Flight at Initial Constant Airspeed End Evaluation: Steady Flight at New Constant Airspeed		

Evaluation Basis: Check ability to initiate climb during normal operations. Check for undesirable airspeed coupling.

Performance Standards	Target	Desired	Adequate
Deviation in Bank Angle (deg)	0	±2	±5
Deviation in Target Rate of Climb (fpm)	0	±200	±300
Deviation in Heading (deg)	0	±2	±5
Overshoot/Undershoot in Airspeed (KEAS)	0	±10	±20

3072 **Airspeed Change in Supersonic Cruise**

Flight Phase	MTE	Weather State	Failures
7A. Supersonic Cruise	230. Airspeed Change	1. Light Turb.	0. No Failures
Loading: 5. MIC - Initial Cruise condition			

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Light/ None	0	Unlimited/ Unlimited	Dry, grooved	N/A

ALT	50,000	EPR	Trim	PSCAS	NORMAL		
KEAS/M	450	R/C	0	RSCAS	NORMAL		
GW	614,864			A/T	OFF		
C.G.	52.5			HUD	ON		
GEAR	UP			F/D	OFF		
LEF/TEF	Auto			Config	*Ref H Cyc 3*		

Abnormals/Exceptions:
Thrust Multiplier set to 1.09

Procedure–Evaluation Pilot (PF):
1. PF establishes straight and level flight at the noted conditions.
2. PF smoothly applies power (up to MCT) to accelerate the airplane to 475 KEAS (or to the highest standard airspeed/Mach for the flight condition) while maintaining altitude, heading and wings level.
3. Stabilize at 475 KEAS.
4. PF smoothly reduces power to return to initial airpeed, while maintaining climb rate, heading, and bank angle.
5. Thrust may be adjusted to assist in the smooth performance of this maneuver.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.

Date: ____________ **Pilot:** ____________________ **Runs:** __________

Evaluation Segment: Airspeed Change in Level Flight (Supersonic)	Long CHR	Lat / Dir CHR
Start Evaluation: Steady Flight at Initial Constant Airspeed		
End Evaluation: Steady Flight at New Constant Airspeed		

Evaluation Basis: Check ability to adjust airspeed during normal operations. Check for undesirable airspeed coupling.

Performance Standards	Target	Desired	Adequate
Deviation in Bank Angle (deg)	0	±2	±5
Deviation in Altitude (ft)	0	±50	±100
Deviation in Heading (deg)	0	±2	±5
Overshoots of Target Airspeed/Mach	0	0	≤1

3072

3074 **Transonic Decel**

Flight Phase	MTE	Weather State	Failures
9A. Transonic Decel	230. Airspeed Change	1. Light Turb.	0. No Failures
Loading: 7. MFC - Final Cruise condition			

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Light/ None	0	Unlimited/ Unlimited	Dry, grooved	N/A

ALT	41,000	EPR	Trim	PSCAS	NORMAL
KEAS/M	M 0.99	R/C	0	RSCAS	NORMAL
GW	384,862			A/T	OFF
C.G.	53.2			HUD	ON
GEAR	UP			F/D	OFF
LEF/TEF	Auto			Config	*Ref H Cyc 3*

Abnormals/Exceptions:
None.

Procedure–Evaluation Pilot (PF):
1. PF establishes straight and level flight at the noted conditions.
2. PF smoothly reduces power to decelerate the airplane to 0.90M (or to the highest standard airspeed/Mach for the flight condition) while maintaining altitude, heading and wings level.
3. Stabilize at 0.9M.
4. PF smoothly increases power to return to initial Mach number, while maintaining altitude, heading, and bank angle.
5. Thrust may be adjusted to assist in the smooth performance of this maneuver.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.

Date: __________ **Pilot:** __________________ **Runs:** __________

Evaluation Segment: Airspeed Change in Level Flight (Transonic)
Start Evaluation: Steady Flight at Initial Constant Airspeed
End Evaluation: Steady Flight at New Constant Airspeed

Long CHR	Lat / Dir CHR

Evaluation Basis: Check ability to adjust airspeed during normal operations. Check for undesirable airspeed coupling.

Performance Standards	Target	Desired	Adequate
Deviation in Bank Angle (deg)	0	±2	±5
Deviation in Altitude (ft)	0	±100	±200
Deviation in Heading (deg)	0	±2	±5
Overshoots of Target Airspeed/Mach	0	0	≤1

3076 **Subsonic Decel**

Flight Phase	MTE	Weather State	Failures
12A. Low Altitude Cruise/Hold	230. Airspeed Change	1. Light Turb.	0. No Failures

Loading: 7. MFC - Final Cruise condition

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Light/ None	0	Unlimited/ Unlimited	Dry, grooved	N/A

ALT	15,000	EPR	Trim	PSCAS	NORMAL
KEAS/M	350	R/C	0	RSCAS	NORMAL
GW	384,862			A/T	OFF
C.G.	53.2			HUD	ON
GEAR	UP			F/D	OFF
LEF/TEF	Auto			Config	*Ref H Cyc 3*

Abnormals/Exceptions:
None.

Procedure–Evaluation Pilot (PF):
1. PF establishes straight and level flight at the noted conditions.
2. PF smoothly reduces power to decelerate the airplane to 250 KEAS (or to the highest standard airspeed/Mach for the flight condition) while maintaining altitude, heading and wings level.
3. Stabilize at 250 KEAS.
4. PF smoothly increases power to return to initial airspeed, while maintaining altitude, heading, and bank angle.
5. Thrust may be adjusted to assist in the smooth performance of this maneuver.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.

Date: ____________ **Pilot:** ____________________ **Runs:** ____________

Evaluation Segment: Airspeed Change in Level Flight (Subsonic)
Start Evaluation: Steady Flight at Initial Constant Airspeed
End Evaluation: Steady Flight at New Constant Airspeed

Long CHR	Lat / Dir CHR

Evaluation Basis: Check ability to adjust airspeed during normal operations. Check for undesirable airspeed coupling.

Performance Standards	Target	Desired	Adequate
Deviation in Bank Angle (deg)	0	±2	±5
Deviation in Altitude (ft)	0	±100	±200
Deviation in Heading (deg)	0	±2	±5
Overshoots of Target Airspeed/Mach	0	0	≤1

3080 Heading Change in Transonic Climb

Flight Phase	MTE	Weather State	Failures
5A. Transonic Climb	240. Heading Change	1. Light Turb.	0. No Failures

Loading:	3. M13 - Max Taxi Weight @ fwd C.G., full aft fuselage fuel, partial wing fuel, max payload

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Light/ None	0	Unlimited/ Unlimited	Dry, grooved	N/A

ALT	26,000	EPR	Trim	PSCAS	NORMAL
KEAS/M	M 0.88	R/C	1000	RSCAS	NORMAL
GW	649,914			A/T	OFF
C.G.	48.1			HUD	ON
GEAR	UP			F/D	OFF
LEF/TEF	Auto			Config	*Ref H Cyc 3*

Abnormals/Exceptions:
None.

Procedure–Evaluation Pilot (PF):
1. Establish steady constant-heading climb at 0.88M on a cardinal heading with a 1000 ft/min rate of climb.
2. Aggressively maneuver into and out of a 30° turn to the RIGHT using a 15° bank angle while maintaining airspeed and rate of climb. Thrust may be adjusted if necessary.
3. Repeat maneuver to the LEFT using 30° bank.
4. Repeat maneuver using opposite directions of turn.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.

Date: ____________ **Pilot:** ____________________ **Runs:** ____________

Evaluation Segment:	Heading Change in Climb/Descent (Transonic)	Long CHR	Lat / Dir CHR
Start Evaluation:	Straight Flight on Initial Heading		
End Evaluation:	Straight Flight on New Heading		

Evaluation Basis: Evaluate handling qualities in turning flight. Perform maneuver with smooth roll-in and roll-out, with no tendency to oscillate or hunt for target bank angle throughout the maneuver.

Performance Standards	Target	Desired	Adequate
Deviation from Target Bank Angle in Turn (deg)	0	±2	±5
Deviation in Rate of Climb/Descent (ft/m)	0	±300	±500
Deviation in Airspeed/Mach (KEAS)	0	±5/0.01M	±10/0.02M
Deviation from Target Heading at End of Turn (deg)	0	±2 (0 overshoots)	±5 (≤1 overshoot)

3082 **Heading Change in Supersonic Cruise**

Flight Phase	MTE	Weather State	Failures
7A. Supersonic Cruise	240. Heading Change	1. Light Turb.	0. No Failures

Loading: 5. MIC - Initial Cruise condition

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Light/ None	0	Unlimited/ Unlimited	Dry, grooved	N/A

ALT	54,400	EPR	Trim	PSCAS	NORMAL
KEAS/M	M 2.3	R/C	0	RSCAS	NORMAL
GW	614,864			A/T	OFF
C.G.	52.5			HUD	ON
GEAR	UP			F/D	OFF
LEF/TEF	Auto			Config	*Ref H Cyc 3*

Abnormals/Exceptions:
Thrust Multiplier set to 1.09

Procedure–Evaluation Pilot (PF):
1. Establish straight and level flight at indicated conditions on a cardinal heading.
2. Aggressively maneuver into and out of a 20° turn to the RIGHT using a 15° bank angle while maintaining airspeed and level flight. Thrust may be adjusted if necessary. Accept altitude loss to maintain Mach if required.
3. Repeat maneuver to the LEFT using 30° bank.
4. Repeat maneuver using opposite directions of turn.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.

Date: ____________ **Pilot:** ______________________ **Runs:** ____________

Evaluation Segment: Heading Change in Level Flight (Supersonic)
Start Evaluation: Straight Flight on Initial Heading
End Evaluation: Straight Flight on New Heading

Long CHR	Lat / Dir CHR

Evaluation Basis: Evaluate handling qualities in turning flight. Perform maneuver with smooth roll-in and roll-out, with no tendency to oscillate or hunt for target bank angle throughout the maneuver.

Performance Standards	Target	Desired	Adequate
Deviation from Target Bank Angle in Turn (deg)	0	±2	±5
Deviation in Altitude (ft)	0	±100	±200
Deviation in Mach	0	±0.01	±0.02
Deviation from Target Heading at End of Turn (deg)	0	±2 (0 overshoots)	±5 (≤1 overshoot)

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3084 Heading Change in Supersonic Cruise

Flight Phase	MTE	Weather State	Failures
7C. Supersonic Cruise	240. Heading Change	1. Light Turb.	0. No Failures

Loading: 7. MFC - Final Cruise condition

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Light/ None	0	Unlimited/ Unlimited	Dry, grooved	N/A

ALT	64,590	EPR	Trim	PSCAS	NORMAL
KEAS/M	M 2.4	R/C	0	RSCAS	NORMAL
GW	384,862			A/T	OFF
C.G.	53.2			HUD	ON
GEAR	UP			F/D	OFF
LEF/TEF	Auto			Config	*Ref H Cyc 3*

Abnormals/Exceptions:
Thrust Multiplier set to 1.09

Procedure–Evaluation Pilot (PF):
1. Establish straight and level flight at indicated conditions on a cardinal heading.
2. Aggressively maneuver into and out of a 20° turn to the RIGHT using a 15° bank angle while maintaining airspeed and level flight. Thrust may be adjusted if necessary. Accept altitude loss to maintain Mach if required.
3. Repeat maneuver to the LEFT using 30° bank.
4. Repeat maneuver using opposite directions of turn.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.

Date: ____________ **Pilot:** ______________________ **Runs:** ____________

Evaluation Segment: Heading Change in Level Flight (Supersonic)	Long CHR	Lat / Dir CHR
Start Evaluation: Straight Flight on Initial Heading End Evaluation: Straight Flight on New Heading		

Evaluation Basis: Evaluate handling qualities in turning flight. Perform maneuver with smooth roll-in and roll-out, with no tendency to oscillate or hunt for target bank angle throughout the maneuver.

Performance Standards	Target	Desired	Adequate
Deviation from Target Bank Angle in Turn (deg)	0	±2	±5
Deviation in Altitude (ft)	0	±100	±200
Deviation in Mach	0	±0.01	±0.02
Deviation from Target Heading at End of Turn (deg)	0	±2 (0 overshoots)	±5 (≤1 overshoot)

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3086 Heading Change in Low Altitude Cruise

Flight Phase	MTE	Weather State	Failures
12A. Low Altitude Cruise/Hold	240. Heading Change	1. Light Turb.	0. No Failures

Loading: 7. MFC - Final Cruise condition

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Light/ None	0	Unlimited/ Unlimited	Dry, grooved	N/A

ALT	15,000	EPR	Trim	PSCAS	NORMAL
KEAS/M	350	R/C	0	RSCAS	NORMAL
GW	384,862			A/T	OFF
C.G.	53.2			HUD	ON
GEAR	UP			F/D	OFF
LEF/TEF	Auto			Config	*Ref H Cyc 3*

Abnormals/Exceptions:
None.

Procedure–Evaluation Pilot (PF):
1. Establish straight and level flight at indicated conditions on a cardinal heading.
2. Aggressively maneuver into and out of a 60° turn to the RIGHT using a 30° bank angle while maintaining airspeed and level flight. Thrust may be adjusted if necessary.
3. Repeat maneuver to the LEFT.
4. Repeat maneuver using opposite directions of turn.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.

Date: ____________ **Pilot:** ____________ **Runs:** ____________

Evaluation Segment: Heading Change in Level Flight (Subsonic)	Long CHR	Lat / Dir CHR
Start Evaluation: Straight Flight on Initial Heading End Evaluation: Straight Flight on New Heading		

Evaluation Basis: Evaluate handling qualities in turning flight. Perform maneuver with smooth roll-in and roll-out, with no tendency to oscillate or hunt for target bank angle throughout the maneuver.

Performance Standards	Target	Desired	Adequate
Deviation from Target Bank Angle in Turn (deg)	0	±2	±5
Deviation in Altitude (ft)	0	±100	±200
Deviation in Airspeed (KEAS)	0	±5	±10
Deviation from Target Heading at End of Turn (deg)	0	±2 (0 overshoots)	±5 (≤1 overshoot)

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3088 Heading Change in Class B Descent

Flight Phase	MTE	Weather State	Failures
13A. Descent into Class B Airspace	240. Heading Change	1. Light Turb.	0. No Failures

Loading: 7. MFC - Final Cruise condition

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Light/ None	0	Unlimited/ Unlimited	Dry, grooved	N/A

ALT	10,000	EPR	Trim	PSCAS	NORMAL
KEAS/M	250	R/C	-1000	RSCAS	NORMAL
GW	384,862			A/T	OFF
C.G.	53.2			HUD	ON
GEAR	UP			F/D	OFF
LEF/TEF	Auto			Config	*Ref H Cyc 3*

Abnormals/Exceptions:
None.

Procedure–Evaluation Pilot (PF):
1. Establish steady descent on a cardinal heading.
2. Aggressively maneuver into and out of a 60° turn to the RIGHT using a 15° bank angle while maintaining airspeed and -1000 ft/m descent. Thrust may be adjusted if necessary.
3. Repeat maneuver to the LEFT using 30° bank.
4. Repeat maneuver using opposite directions of turn.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.

Date: ____________ **Pilot:** ____________________ **Runs:** ____________

Evaluation Segment: Heading Change in Climb/Descent (Subsonic)
Start Evaluation: Straight Flight on Initial Heading
End Evaluation: Straight Flight on New Heading

Long CHR	Lat / Dir CHR

Evaluation Basis: Evaluate handling qualities in turning flight. Perform maneuver with smooth roll-in and roll-out, with no tendency to oscillate or hunt for target bank angle throughout the maneuver.

Performance Standards	Target	Desired	Adequate
Deviation from Target Bank Angle in Turn (deg)	0	±2	±5
Deviation in Rate of Climb/Descent (ft/m)	0	±300	±500
Deviation in Airspeed (KEAS)	0	±5	±10
Deviation from Target Heading at End of Turn (deg)	0	±2 (0 overshoots)	±5 (≤1 overshoot)

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Nominal Approach & Landing

Flight Phase	MTE	Weather State	Failures
15A. Initial Approach Fix	313. Complete Approach and Landing	1. Light Turb.	0. No Failures

Loading: 7. MFC - Final Cruise condition

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Light/ None	0	Unlimited/ Unlimited	Dry, grooved	3 nm outside OM; On course for 30° intercept of LOC; 4,500 right of centerline

ALT	1,500	Vapp	159	PSCAS	NORMAL
KEAS/M	190	Vref	154	RSCAS	NORMAL
GW	384,862	Vg/a	159	A/T	ON
C.G.	53.2	Vmin	125	HUD	ON
GEAR	UP			F/D	OFF
LEF/TEF	Auto			Config	*Ref H Cyc 3*

Abnormals/Exceptions:
None.

Procedure–Evaluation Pilot (PF):
1. Establish aircraft in steady level flight at the noted conditions, on intercept course for LOC.
2. Slow to Vapp when instructed by PNF.
3. Capture LOC. Track LOC to G/S intercept and capture G/S.
4. Disconnect autothrottles at 50 ft AGL.
5. Manually retard throttles and execute a flare to touchdown at the target point on the runway.
6. After touchdown, retard throttles to idle and lower the nosewheel to the runway.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.
2. Set Vapp as commanded speed at DME 7.0
3. 1/2 dot before G/S capture, call "Gear Down" and move gear handle to the down position

Date: ____________ **Pilot:** ____________________ **Runs:** __________

Evaluation Segment: Glideslope and Localizer Intercept
Start Evaluation: 1,500 ft, Final Approach Speed, Level
End Evaluation: 200 ft AGL, Landing Speed, Descending

Long CHR	Lat / Dir CHR

Evaluation Basis: Evaluate the ability to accurately maneuver onto the final approach path and maintain nominal approach profile and speed at low altitudes. Attained trimmed flight before the middle marker (approximately 0.5 nm from the end of the runway).

Performance Standards	Target	Desired	Adequate
Deviation from Final Approach Airspeed (kt)	0	±5	±10
Deviation from Glideslope (dots)	0	±0.5	±1.0
Deviation from Localizer (dots)	0	±0.5	±1.0

Evaluation Segment: Precision Landing
Start Evaluation: 200 ft AGL, Landing Speed, Descending
End Evaluation: Nosewheel touchdown

Long CHR	Lat / Dir CHR

Evaluation Basis: Evaluate handling qualities in landing. For desired performance, there should be no tendency to PIO or bobble in pitch or roll. There should also be no tendency to float or bounce after touchdown.There should be no geometry strikes on touchdown.

Performance Standards	Target	Desired	Adequate
Deviation from Approach Airspeed at 50 ft (kt)	0	±5	±10
Deviation from Runway Heading at touchdown (deg)	0	±3	±6
Longitudinal distance from threshold at touchdown (ft)	1250	1000-1500	750-2250
Lateral offset from runway centerline at touchdown (ft)	0	±10	±27
Sink Rate at touchdown (ft/sec)	<1	≤4	≤7
Maximum Bank Angle below 50 ft AGL (deg)	0	±5	±7
Pilot Induced Oscillations (PIO)	No PIO	No PIO	Not Divergent
Geometry Strikes (tail, engine nacelle, wing tip)	No Strikes	No Strikes	No Strikes

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IAG Lateral Offset Landing

Flight Phase	MTE	Weather State	Failures
15B. Maneuver to Final Approach Fix	314. Approach and Landing from Lateral Offset	11. Light Turb. w/Gusts	0. No Failures

Loading: 7. MFC - Final Cruise condition

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Light/ None	0	Unlimited/ Unlimited	Dry, grooved	Outside OM, at 1,000 AGL

ALT	1,500	Vapp	159	PSCAS	NORMAL
KEAS/M	159	Vref	154	RSCAS	NORMAL
GW	384,862	Vg/a	159	A/T	ON
C.G.	53.2	Vmin	125	HUD	ON
GEAR	DOWN			F/D	OFF
LEF/TEF	Auto			Config	*Ref H Cyc 3*

Abnormals/Exceptions:
ILS localizer should be offset 300 feet to one side of the runway centerline, 1581 feet from the runway threshold, and the glideslope set to 2.50°.

Note: Procedure should be repeated for a total of 3 approaches and landings. Turbulence and discrete gusts added on second and third approaches.

Procedure–Evaluation Pilot (PF):
1. Establish aircraft in steady level flight on downwind, dog-leg, or straight-in for LOC capture, as called for by test engineer, for G/S intercept.
2. Maintain Vapp.
3. Establish turn at no less than 3 miles from runway threshold and descend in altitude as required to track LOC to G/S intercept and capture G/S.
4. Track LOC and G/S using HUD, following the offset localizer raw data.
5. When PNF calls "Correct", PF visually maneuvers as required to correct for the lateral offset and set up for a touchdown at the target point on the runway.
6. Disconnect autothrottles at 50 ft AGL.
7. Manually adjust throttles as required and execute a flare to touchdown at the target point on the runway.
8. If not in TIFS, after touchdown, retard throttles to idle and lower the nosewheel to the runway.

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Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.
2. During approach, PNF monitors any performance indicators that will not be automatically reported at the end of the run.
3. At 250 ft AGL, call "Correct"

Date: ____________ **Pilot:** ______________________ **Runs:** ____________

Evaluation Segment: IAG Approach

Start Evaluation: 1,000 ft AGL, Final Approach Speed, Level
End Evaluation: 50 feet AGL, Pre-Flare, Descending

Long CHR	Lat / Dir CHR

Evaluation Basis: Evaluate the ability to accurately maneuver onto the final approach path and maintain nominal approach profile and speed down the Decision Height (when "Correct" is called). Evaluate the ability to maneuver aircraft into landing line-up from offset ILS approach guidance and establish satisfactory pre-flare landing conditions.

Performance Standards	Target	Desired	Adequate
Deviation from Approach Airspeed (kt) [AGL > DH]	0	±5	±10
Deviation from Glideslope (dots) [AGL > DH]	0	±0.5	±1.0
Deviation from Localizer (dots) [AGL > DH]	0	±0.5	±1.0

Evaluation Segment: IAG Landing

Start Evaluation: 50 ft AGL, Pre-Flare, Descending
End Evaluation: Main Gear Touchdown (Nosewheel Touchdown, if not in TIFS)

Long CHR	Lat / Dir CHR

Evaluation Basis: Evaluate handling qualities in landing for a high-gain task. For desired performance, the pilot should be able to precisely and positively control the aircraft touchdown and there should be no tendency to PIO or bobble in pitch and roll. There should also be no tendency to float in flare. There should be no geometry strikes.

Performance Standards	Target	Desired	Adequate
Longitudinal distance from threshold at touchdown (ft)	1250	1000-1500	750-2250
Lateral offset from runway centerline at touchdown (ft)	0	±10	±27
Sink Rate at touchdown (ft/sec)	<1	≤4	≤7
Maximum Bank Angle below 35 ft AGL (deg)	0	±5	±7
Pilot Induced Oscillations (PIO)	No PIO	No PIO	Not Divergent
Geometry Strikes (tail, engine nacelle, wing tip)	No Strikes	No Strikes	No Strikes

30' Go-Around with Minimum Altitude Loss

Flight Phase	MTE	Weather State	Failures
17E. Landing	307. Go-Around - Min Alt Loss	301. Cat IIIa - Lt. Turb	0. No Failures

Loading: 16. M3F - MZFW+Body Fuel+Wing Fuel, Fwd C.G.

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Light/ None	3A	50 ft/ 600 ft	Dry, grooved	On G/S and LOC about 3 miles from touchdown, at 750 feet AGL

ALT	750 AGL	Vapp	159	PSCAS	NORMAL
KEAS/M	159	Vref	154	RSCAS	NORMAL
GW	384,862	Vg/a	159	A/T	ON
C.G.	47.3	Vmin	125	HUD	ON
GEAR	DOWN			F/D	OFF
LEF/TEF	Auto			Config	*Ref H Cyc 3*

Abnormals/Exceptions:
None.

Procedure–Evaluation Pilot (PF):
1. Establish aircraft on LOC and G/S.
2. Maintain Vapp.
3. Track LOC and G/S using HUD.
4. When PNF calls "Go-round," pitch nose up to capture a target flight path angle of 12°, while simultaneously pushing the TO/GA button and advancing throttles to go-around thrust. The time to initially acquire the target flight path angle should be 7 sec.
5. Terminate test when target climb pitch attitude has been established and stabilized.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.
2. During approach, PNF monitors any performance indicators that will not be automatically reported at the end of the run.
3. At 30 feet radio altitude, call out "Go-Around".

Date: ____________ **Pilot:** ______________________ **Runs:** __________

Evaluation Segment: Minimum Altitude Loss Go-Around	Long CHR	Lat / Dir CHR
Start Evaluation: 30' AGL, Final Approach Speed, Descending End Evaluation: Stabilized Climb Flight Path		

Evaluation Basis: Evaluate the ability to go around from a very low altitude without contacting the runway with a minimum of airspeed loss. For desired performance, there should be no tendency to PIO or bobble in pitch or roll. There should be no geometry strikes

Performance Standards	Target	Desired	Adequate
Overshoot of Target Flight Path (deg)	0	±2	±3
Altitude Loss (ft)	<20	<20	<30
Bank Angle Control (deg)	0	±5	±10
Pilot Induced Oscillations	No PIO	No PIO	Not Divergent
Geometry Strikes (tail, engine nacelle, wing tip)	No Strikes	No Strikes	No Strikes

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4086 **50' Go-Around with Minimum Altitude Loss**

Flight Phase	MTE	Weather State	Failures
17E. Landing	**307.** Go-Around - Min Alt Loss	**301.** Cat IIIa - Lt. Turb	**0.** No Failures

Loading: **21.** MLWF - Min Landing Weight, Fwd C.G.

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Light/ None	3A	50 ft/ 600 ft	Dry, grooved	On G/S and LOC about 3 miles from touchdown, at 750 feet AGL

ALT	750 AGL	**Vapp**	143	**PSCAS**	NORMAL
KEAS/M	143	**Vref**	138	**RSCAS**	NORMAL
GW	307,000	**Vg/a**	143	**A/T**	ON
C.G.	48	**Vmin**	112	**HUD**	ON
GEAR	DOWN			**F/D**	OFF
LEF/TEF	Auto			**Config**	*Ref H Cyc 3*

Abnormals/Exceptions:
None.

Procedure–Evaluation Pilot (PF):
1. Establish aircraft on LOC and G/S.
2. Maintain Vapp.
3. Track LOC and G/S using HUD.
4. When PNF calls "Go-round," pitch nose up to capture a target flight path angle of 12°, while simultaneously pushing the TO/GA button and advancing throttles to go-around thrust. The time to initially acquire the target flight path angle should be 7 sec.
5. Terminate test when target climb pitch attitude has been established and stabilized.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.
2. During approach, PNF monitors any performance indicators that will not be automatically reported at the end of the run.
3. At 50 feet radio altitude, call out "Go-Around".

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Date: ____________ **Pilot:** ____________________ **Runs:** ____________

Evaluation Segment: Minimum Altitude Loss Go-Around
Start Evaluation: 50' AGL, Final Approach Speed, Descending
End Evaluation: Stabilized Climb Flight Path

Long CHR	Lat / Dir CHR

Evaluation Basis: Evaluate the ability to go around from a very low altitude without contacting the runway with a minimum of airspeed loss. For desired performance, there should be no tendency to PIO or bobble in pitch or roll. There should be no geometry strikes

Performance Standards	Target	Desired	Adequate
Overshoot of Target Flight Path (deg)	0	±2	±3
Altitude Loss (ft)	<20	<20	<30
Bank Angle Control (deg)	0	±5	±10
Pilot Induced Oscillations	No PIO	No PIO	Not Divergent
Geometry Strikes (tail, engine nacelle, wing tip)	No Strikes	No Strikes	No Strikes

4093 25 Kt Crosswind Approach and Landing

Flight Phase	MTE	Weather State	Failures
15B. Maneuver to Final Approach Fix	313. Complete Approach and Landing	30A. 25 Kt Crosswind	0. No Failures

Loading: 7. MFC - Final Cruise condition

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 25 Kt	Moderate/ None	0	Unlimited/ Unlimited	Dry, grooved	1/2 mi outside OM, at 1,500 feet AGL, on LOC.

ALT	1,500	Vapp	159	PSCAS	NORMAL
KEAS/M	159	Vref	154	RSCAS	NORMAL
GW	384,862	Vg/a	159	A/T	ON
C.G.	53.2	Vmin	125	HUD	ON
GEAR	DOWN			F/D	OFF
LEF/TEF	Auto			Config	*Ref H Cyc 3*

Abnormals/Exceptions:
None.

Note: X-wind decreases linearly from 35 kt at 1000 ft AGL to 25 kt at field elevation.

Procedure–Evaluation Pilot (PF):

1. Establish aircraft in steady level flight at the noted conditions, tracking the LOC for G/S intercept.
2. Maintain Vapp.
3. Track LOC to G/S intercept and capture G/S using HUD or PFD.
4. Procedure A: Disconnect autothrottles at 50 ft AGL.
5. Procedure A: At 50 ft AGL, initiate a decrab and flare maneuver to touchdown at the target point. Max bank angle 5 deg.
6. Procedure B: At 200 ft AGL, initiate a forward slip (max bank angle 5 deg).
7. Procedure B: Disconnect autothrottles at 50 ft AGL.
8. Procedure B: Execute a flare to touchdown at the target point on the runway. Max bank angle is 5 deg.
9. After touchdown, retard throttles to idle and lower the nosewheel to the runway.

Procedure–Test Engineer / Pilot Not Flying (PNF):

1. Confirm initial conditions.
2. During approach, PNF monitors any performance indicators that will not be automatically reported at the end of the run.

Date: ____________ **Pilot:** ____________________ **Runs:** __________

Evaluation Segment: Glideslope and Localizer Intercept
Start Evaluation: 1,500 ft, Final Approach Speed, Level
End Evaluation: 200 ft AGL, Landing Speed, Descending

Long CHR	Lat / Dir CHR

Evaluation Basis: Evaluate the ability to accurately maneuver onto the final approach path and maintain nominal approach profile and speed at low altitudes. Attained trimmed flight before the middle marker (approximately 0.5 nm from the end of the runway).

Performance Standards	Target	Desired	Adequate
Deviation from Final Approach Airspeed (kt)	0	±5	±10
Deviation from Glideslope (dots)	0	±0.5	±1.0
Deviation from Localizer (dots)	0	±0.5	±1.0

Evaluation Segment: Precision Landing
Start Evaluation: 200 ft AGL, Landing Speed, Descending
End Evaluation: Nosewheel touchdown

Long CHR	Lat / Dir CHR

Evaluation Basis: Evaluate handling qualities in landing. For desired performance, there should be no tendency to PIO or bobble in pitch or roll. There should also be no tendency to float or bounce after touchdown.There should be no geometry strikes on touchdown.

Performance Standards	Target	Desired	Adequate
Deviation from Approach Airspeed at 50 ft (kt)	0	±5	±10
Deviation from Runway Heading at touchdown (deg)	0	±3	±6
Longitudinal distance from threshold at touchdown (ft)	1250	1000-1500	750-2250
Lateral offset from runway centerline at touchdown (ft)	0	±10	±27
Sink Rate at touchdown (ft/sec)	<1	≤4	≤7
Maximum Bank Angle below 50 ft AGL (deg)	0	±5	±7
Pilot Induced Oscillations (PIO)	No PIO	No PIO	Not Divergent
Geometry Strikes (tail, engine nacelle, wing tip)	No Strikes	No Strikes	No Strikes

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4095 35 Kt Crosswind Approach and Landing

Flight Phase	MTE	Weather State	Failures
15B. Maneuver to Final Approach Fix	313. Complete Approach and Landing	31. 35 Kt Crosswind	0. No Failures
Loading: 7. MFC - Final Cruise condition			

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 35 Kt	Moderate/ None	0	Unlimited/ Unlimited	Dry, grooved	1/2 mi outside OM, at 1,500 feet AGL, on LOC.

ALT	1,500	Vapp	159	PSCAS	NORMAL
KEAS/M	159	Vref	154	RSCAS	NORMAL
GW	384,862	Vg/a	159	A/T	ON
C.G.	53.2	Vmin	125	HUD	ON
GEAR	DOWN			F/D	OFF
LEF/TEF	Auto			Config	*Ref H Cyc 3*

Abnormals/Exceptions:
None.

Note: X-wind decreases linearly from 45 kt at 1000 ft AGL to 35 kt at field elevation.

Procedure–Evaluation Pilot (PF):
1. Establish aircraft in steady level flight at the noted conditions, tracking the LOC for G/S intercept.
2. Maintain Vapp.
3. Track LOC to G/S intercept and capture G/S using HUD or PFD.
4. Procedure A: Disconnect autothrottles at 50 ft AGL.
5. Procedure A: At 50 ft AGL, initiate a decrab and flare maneuver to touchdown at the target point. Max bank angle 5 deg.
6. Procedure B: At 200 ft AGL, initiate a forward slip (max bank angle 5 deg).
7. Procedure B: Disconnect autothrottles at 50 ft AGL.
8. Procedure B: Execute a flare to touchdown at the target point on the runway. Max bank angle is 5 deg.
9. After touchdown, retard throttles to idle and lower the nosewheel to the runway.

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Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.
2. During approach, PNF monitors any performance indicators that will not be automatically reported at the end of the run.

Date: ________ **Pilot:** ________ **Runs:** ________

Evaluation Segment: Glideslope and Localizer Intercept
Start Evaluation: 1,500 ft, Final Approach Speed, Level
End Evaluation: 200 ft AGL, Landing Speed, Descending

Long CHR	Lat / Dir CHR

Evaluation Basis: Evaluate the ability to accurately maneuver onto the final approach path and maintain nominal approach profile and speed at low altitudes. Attained trimmed flight before the middle marker (approximately 0.5 nm from the end of the runway).

Performance Standards	Target	Desired	Adequate
Deviation from Final Approach Airspeed (kt)	0	±5	±10
Deviation from Glideslope (dots)	0	±0.5	±1.0
Deviation from Localizer (dots)	0	±0.5	±1.0

Evaluation Segment: Precision Landing
Start Evaluation: 200 ft AGL, Landing Speed, Descending
End Evaluation: Nosewheel touchdown

Long CHR	Lat / Dir CHR

Evaluation Basis: Evaluate handling qualities in landing. For desired performance, there should be no tendency to PIO or bobble in pitch or roll. There should also be no tendency to float or bounce after touchdown.There should be no geometry strikes on touchdown.

Performance Standards	Target	Desired	Adequate
Deviation from Approach Airspeed at 50 ft (kt)	0	±5	±10
Deviation from Runway Heading at touchdown (deg)	0	±3	±6
Longitudinal distance from threshold at touchdown (ft)	1250	1000-1500	750-2250
Lateral offset from runway centerline at touchdown (ft)	0	±10	±27
Sink Rate at touchdown (ft/sec)	<1	≤4	≤7
Maximum Bank Angle below 50 ft AGL (deg)	0	±5	±7
Pilot Induced Oscillations (PIO)	No PIO	No PIO	Not Divergent
Geometry Strikes (tail, engine nacelle, wing tip)	No Strikes	No Strikes	No Strikes

4110 Approach and Landing with Jammed Control

Flight Phase	MTE	Weather State	Failures
15A. Initial Approach Fix	313. Complete Approach and Landing	1. Light Turb.	25. Stabilizer Jam

Loading: 7. MFC - Final Cruise condition

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Light/ None	0	Unlimited/ Unlimited	Dry, grooved	3 nm outside OM; On LOC

ALT	1,500	Vapp	159	PSCAS	NORMAL
KEAS/M	190	Vref	154	RSCAS	NORMAL
GW	384,862	Vg/a	159	A/T	ON
C.G.	53.2	Vmin	125	HUD	ON
GEAR	UP			F/D	OFF
LEF/TEF	Auto			Config	*Ref H Cyc 3*

Abnormals/Exceptions:
Jammed Stabilizer

Procedure–Evaluation Pilot (PF):
1. Establish aircraft in steady level flight at the noted conditions, tracking the LOC.
2. Slow to Vapp prior to intercepting glideslope.
3. Capture G/S. Track LOC and G/S using raw ILS on HUD or PFD.
4. Disconnect autothrottles at 50 ft AGL.
5. Manually retard throttles and execute a flare to touchdown at the target point on the runway.
6. After touchdown, retard throttles to idle and lower the nosewheel to the runway.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.
2. Set Vapp as commanded speed at DME 7.0
3. 1/2 dot before G/S capture, call "Gear Down" and move gear handle to the down position

Date: ____________ **Pilot:** ______________________ **Runs:** ____________

Evaluation Segment: Glideslope and Localizer Intercept
Start Evaluation: 1,500 ft, Final Approach Speed, Level
End Evaluation: 200 ft AGL, Landing Speed, Descending

Long CHR	Lat / Dir CHR

Evaluation Basis: Evaluate the ability to accurately maneuver onto the final approach path and maintain nominal approach profile and speed at low altitudes. Attained trimmed flight before the middle marker (approximately 0.5 nm from the end of the runway).

Performance Standards	Target	Desired	Adequate
Deviation from Final Approach Airspeed (kt)	0	±5	±10
Deviation from Glideslope (dots)	0	±0.5	±1.0
Deviation from Localizer (dots)	0	±0.5	±1.0

Evaluation Segment: Precision Landing
Start Evaluation: 200 ft AGL, Landing Speed, Descending
End Evaluation: Nosewheel touchdown

Long CHR	Lat / Dir CHR

Evaluation Basis: Evaluate handling qualities in landing. For desired performance, there should be no tendency to PIO or bobble in pitch or roll. There should also be no tendency to float or bounce after touchdown.There should be no geometry strikes on touchdown.

Performance Standards	Target	Desired	Adequate
Deviation from Approach Airspeed at 50 ft (kt)	0	±5	±10
Deviation from Runway Heading at touchdown (deg)	0	±3	±6
Longitudinal distance from threshold at touchdown (ft)	1250	1000-1500	750-2250
Lateral offset from runway centerline at touchdown (ft)	0	±10	±27
Sink Rate at touchdown (ft/sec)	<1	≤4	≤7
Maximum Bank Angle below 50 ft AGL (deg)	0	±5	±7
Pilot Induced Oscillations (PIO)	No PIO	No PIO	Not Divergent
Geometry Strikes (tail, engine nacelle, wing tip)	No Strikes	No Strikes	No Strikes

Circling Approach & Landing

Flight Phase	MTE	Weather State	Failures
15B. Maneuver to Final Approach Fix	315. Circling Approach	72. Marginal+ VFR - 35 Kt	0. No Failures

Loading: 7. MFC - Final Cruise condition

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 35 Kt	Moderate/ None	0	1000/ 7 nm	Dry, grooved	1/2 mi. outside OM, at 1,500 ft AGL

ALT	1,500	Vapp	159	PSCAS	NORMAL
KEAS/M	159	Vref	154	RSCAS	NORMAL
GW	384,862	Vg/a	159	A/T	ON
C.G.	53.2	Vmin	125	HUD	ON
GEAR	DOWN			F/D	OFF
LEF/TEF	Auto			Config	*Ref H Cyc 3*

Abnormals/Exceptions:
None.

Note: DME 2.6: Hdg 045; DME 2.6: Hdg 360; DME 3.6: Hdg 260

Procedure–Evaluation Pilot (PF):
1. Maintain G/S and LOC on descent to DEN runway 35R.
2. Upon breakout begin VFR circling approach for line-up with runway 26. Observe minimum altitude of 750 ft and maximum bank angle of 30 deg. prior to completion of final turn. See heading vs. DME table in NOTE above.
3. Disconnect autothrottles at 50 ft AGL.
4. Manually retard throttles and execute a flare to touchdown at the target point on the runway.
5. After touchdown, retard throttles to idle and lower the nosewheel to the runway.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.
2. During approach, PNF monitors any performance indicators that will not be automatically reported at the end of the run.
3. Upon breaking out of clouds, call "Runway in sight".

Date: ____________ **Pilot:** ______________________ **Runs:** __________

Evaluation Segment: Circling Approach	Long CHR	Lat / Dir CHR
Start Evaluation: 1,500 ft, Final Approach Speed, on G/S End Evaluation: 200 ft AGL, Landing Speed, Descending		

Evaluation Basis: Evaluate the ability to rapidly maneuver onto alternate runway using VFR techniques in the terminal area at low altitude.

Performance Standards	Target	Desired	Adequate
Dev. from Final Appr. Airspeed (KEAS)	Vapp	±5	±10
Minimum altitude prior to initiation of final turn (ft)	750 AGL	750 AGL	650 AGL
Maximum bank angle during circling approach (deg)	--	±30	±45

Evaluation Segment: Precision Landing	Long CHR	Lat / Dir CHR
Start Evaluation: 200 ft AGL, Landing Speed, Descending End Evaluation: Nosewheel touchdown		

Evaluation Basis: Evaluate handling qualities in landing. For desired performance, there should be no tendency to PIO or bobble in pitch or roll. There should also be no tendency to float or bounce after touchdown.There should be no geometry strikes on touchdown.

Performance Standards	Target	Desired	Adequate
Deviation from Approach Airspeed at 50 ft (kt)	0	±5	±10
Deviation from Runway Heading at touchdown (deg)	0	±3	±6
Longitudinal distance from threshold at touchdown (ft)	1250	1000-1500	750-2250
Lateral offset from runway centerline at touchdown (ft)	0	±10	±27
Sink Rate at touchdown (ft/sec)	<1	≤4	≤7
Maximum Bank Angle below 50 ft AGL (deg)	0	±5	±7
Pilot Induced Oscillations (PIO)	No PIO	No PIO	Not Divergent
Geometry Strikes (tail, engine nacelle, wing tip)	No Strikes	No Strikes	No Strikes

Decelerating Approach & Landing

Flight Phase	MTE	Weather State	Failures
15B. Maneuver to Final Approach Fix	**313.** Complete Approach and Landing	**1.** Light Turb.	**0.** No Failures

Loading: 7. MFC - Final Cruise condition

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Light/ None	0	Unlimited/ Unlimited	Dry, grooved	1/2 nm outside OM, on LOC.

ALT	1,500	**Vapp1**	185	**PSCAS**	NORMAL
KEAS/M	185	**Vapp2**	159	**RSCAS**	NORMAL
GW	384,862	**Vref**	154	**A/T**	ON
C.G.	53.2	**Vg/a**	159	**HUD**	ON
GEAR	DOWN	**Vmin**	125	**F/D**	OFF
LEF/TEF	Auto			**Config**	*Ref H Cyc 3*

Abnormals/Exceptions:
None.

Procedure–Evaluation Pilot (PF):
1. Establish aircraft in steady level flight at the noted conditions.
2. Track LOC to G/S intercept and capture G/S.
3. Auto-flap decel schedule will initiate at 750 ft AGL. Allow airspeed to decay to Vapp2 at threshold crossing.
4. Disconnect autothrottles at 50 ft. Manually retard throttles and execute a flare to touchdown at the target point on the runway.
5. After touchdown, retard throttles to idle and lower the nosewheel to the runway.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions. Initial speed should be Vapp1, with auto-flap decel schedule armed.
2. 1/2 dot before G/S capture, call out "Gear Down" and move gear handle to the down position

Date: ____________ **Pilot:** ____________________ **Runs:** __________

Evaluation Segment: Glideslope Intercept
Start Evaluation: 1,500 ft, Final Approach Speed, Level
End Evaluation: 200 ft AGL, Landing Speed, Descending

Long CHR	Lat / Dir CHR

Evaluation Basis: Evaluate the ability to rapidly maneuver onto the final approach path at low altitudes. Attained trimmed flight before the middle marker (approximately 0.5 nm from the end of the runway).

Performance Standards	Target	Desired	Adequate
Dev. from Final Appr. Airspeed (KEAS)	Vapp	±5	±10
Deviation from Glideslope (dots)	0	±0.5	±1.0
Deviation from Localizer (dots)	0	±0.5	±1.0

Evaluation Segment: Precision Landing
Start Evaluation: 200 ft AGL, Landing Speed, Descending
End Evaluation: Nosewheel touchdown

Long CHR	Lat / Dir CHR

Evaluation Basis: Evaluate handling qualities in landing. For desired performance, there should be no tendency to PIO or bobble in pitch or roll. There should also be no tendency to float or bounce after touchdown.There should be no geometry strikes on touchdown.

Performance Standards	Target	Desired	Adequate
Deviation from Approach Airspeed at 50 ft (kt)	0	±5	±10
Deviation from Runway Heading at touchdown (deg)	0	±3	±6
Longitudinal distance from threshold at touchdown (ft)	1250	1000-1500	750-2250
Lateral offset from runway centerline at touchdown (ft)	0	±10	±27
Sink Rate at touchdown (ft/sec)	<1	≤4	≤7
Maximum Bank Angle below 50 ft AGL (deg)	0	±5	±7
Pilot Induced Oscillations (PIO)	No PIO	No PIO	Not Divergent
Geometry Strikes (tail, engine nacelle, wing tip)	No Strikes	No Strikes	No Strikes

4225 Decel. Approach & Landing - Manual Throttles

Flight Phase	MTE	Weather State	Failures
15B. Maneuver to Final Approach Fix	313. Complete Approach and Landing	1. Light Turb.	0. No Failures

Loading: 7. MFC - Final Cruise condition

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Light/ None	0	Unlimited/ Unlimited	Dry, grooved	1/2 nm outside OM, on LOC.

ALT	1,500	Vappl	185	PSCAS	NORMAL
KEAS/M	185	Vapp2	159	RSCAS	NORMAL
GW	384,862	Vref	154	A/T	OFF
C.G.	53.2	Vg/a	159	HUD	ON
GEAR	DOWN	Vmin	125	F/D	OFF
LEF/TEF	Auto			Config	*Ref H Cyc 3*

Abnormals/Exceptions:
None.

Procedure–Evaluation Pilot (PF):
1. Establish aircraft in steady level flight at the noted conditions, maintaining Vappl.
2. Track LOC to G/S intercept and capture G/S. At 1400 ft, set throttles to 9%.
3. Track G/S and maintain throttle setting of 9%. Auto-flap decel schedule will initiate at 750 ft AGL. Allow airspeed to decay to Vapp2 at threshold crossing.
4. Execute a flare to touchdown at the target point on the runway.
5. After touchdown, retard throttles to idle and lower the nosewheel to the runway.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions. Initial speed should be Vappl, with auto-flap decel schedule armed.
2. 1/2 dot before G/S capture, call out "Gear Down" and move gear handle to the down position

Date: ____________ **Pilot:** ______________________ **Runs:** ____________

Evaluation Segment: Glideslope Intercept
Start Evaluation: 1,500 ft, Final Approach Speed, Level
End Evaluation: 200 ft AGL, Landing Speed, Descending

Long CHR	Lat / Dir CHR

Evaluation Basis: Evaluate the ability to rapidly maneuver onto the final approach path at low altitudes. Attained trimmed flight before the middle marker (approximately 0.5 nm from the end of the runway).

Performance Standards	Target	Desired	Adequate
Dev. from Final Appr. Airspeed (KEAS)	Vapp	±5	±10
Deviation from Glideslope (dots)	0	±0.5	±1.0
Deviation from Localizer (dots)	0	±0.5	±1.0

Evaluation Segment: Precision Landing
Start Evaluation: 200 ft AGL, Landing Speed, Descending
End Evaluation: Nosewheel touchdown

Long CHR	Lat / Dir CHR

Evaluation Basis: Evaluate handling qualities in landing. For desired performance, there should be no tendency to PIO or bobble in pitch or roll. There should also be no tendency to float or bounce after touchdown.There should be no geometry strikes on touchdown.

Performance Standards	Target	Desired	Adequate
Deviation from Approach Airspeed at 50 ft (kt)	0	±5	±10
Deviation from Runway Heading at touchdown (deg)	0	±3	±6
Longitudinal distance from threshold at touchdown (ft)	1250	1000-1500	750-2250
Lateral offset from runway centerline at touchdown (ft)	0	±10	±27
Sink Rate at touchdown (ft/sec)	<1	≤4	≤7
Maximum Bank Angle below 50 ft AGL (deg)	0	±5	±7
Pilot Induced Oscillations (PIO)	No PIO	No PIO	Not Divergent
Geometry Strikes (tail, engine nacelle, wing tip)	No Strikes	No Strikes	No Strikes

5010 **Stall at Idle Power**

Flight Phase	MTE	Weather State	Failures
13A. Descent into Class B Airspace	400. Stall at Idle Power	1. Light Turb.	0. No Failures

Loading: 7. MFC - Final Cruise condition

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Light/ None	0	Unlimited/ Unlimited	Dry, grooved	N/A

ALT	10,000	EPR	Idle	PSCAS	NORMAL
KEAS/M	155	R/C	Trim	RSCAS	NORMAL
GW	384,862	Vapp	155	A/T	OFF
C.G.	53.2			HUD	ON
GEAR	UP			F/D	OFF
LEF/TEF	Auto			Config	*Ref H Cyc 3*

Abnormals/Exceptions:
None.

Procedure–Evaluation Pilot (PF):
1. Establish straight descending flight at Vapp on a cardinal heading with idle thrust.
2. Using pitch inputs to control flight path angle, establish and maintain a smooth deceleration of 1 knot per second.
3. Decelerate to an airspeed which produces approximately 21 degrees angle-of-attack before initiating recovery.
4. At recovery, lower the nose and maintain wings-level.
5. Terminate the maneuver when recovery is assured (i.e. wings level with AOA less than 13 degrees and steady). No throttle adjustments are allowed.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.
2. Monitor deceleration and call out deviations from the target rate. Verify flaps are automatically extending on schedule.
3. Call out "recover" when angle-of-attack reaches 21 degrees.
4. Verify flaps retract during recovery.
5. Terminate maneuver when recovery is assured (i.e. wings level with AOA less than 13 degrees and steady).

Date: ____________ **Pilot:** ____________________ **Runs:** ____________

Evaluation Segment: Stall
Start Evaluation: Steady flight, wings level
End Evaluation: Wings level at recovered angle of attack condition

Long CHR	Lat / Dir CHR

Evaluation Basis: Manuever possible without exceptional piloting strength or skill. No control reversals or PIO. Recovery never in question.

Performance Standards	Target	Desired	Adequate
Maximum bank angle (deg)	0	±5	±10
Pilot Induced Oscillations (PIO)	No PIO	No PIO	Not Divergent

Stall at Max Takeoff Power

Flight Phase	MTE	Weather State	Failures
3B. Class B Airspace Climb	401. Stall at Max. Takeoff Power	1. Light Turb.	0. No Failures

Loading:	3. M13 - Max Taxi Weight @ fwd C.G., full aft fuselage fuel, partial wing fuel, max payload

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Light/ None	0	Unlimited/ Unlimited	Dry, grooved	N/A

ALT	10,000	EPR	MTO	PSCAS	NORMAL
KEAS/M	186	R/C	Trim	RSCAS	NORMAL
GW	649,914			A/T	OFF
C.G.	48.1			HUD	ON
GEAR	UP			F/D	OFF
LEF/TEF	Auto			Config	*Ref H Cyc 3*

Abnormals/Exceptions:
None.

Procedure–Evaluation Pilot (PF):
1. Establish straight climbing flight on a cardinal heading with MTO thrust.
2. Using pitch inputs to control flight path angle, establish and maintain a smooth deceleration of 1 knot per second.
3. Decelerate to an airspeed which produces approximately 21 degrees angle-of-attack before initiating recovery.
4. At recovery, lower the nose and maintain wings-level.
5. Terminate the maneuver when recovery is assured (i.e. wings level with AOA less than 13 degrees and steady). No throttle adjustments are allowed.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.
2. Monitor deceleration and call out deviations from the target rate. Verify flaps are automatically extending on schedule.
3. Call out "recover" when angle-of-attack reaches 21 degrees.
4. Verify flaps retract during recovery.
5. Terminate maneuver when recovery is assured (i.e. wings level with AOA less than 13 degrees and steady).

Date: ____________ **Pilot:** ______________________ **Runs:** __________

Evaluation Segment: Stall		Long CHR	Lat / Dir CHR
Start Evaluation:	Steady flight, wings level		
End Evaluation:	Wings level at recovered angle of attack condition		

Evaluation Basis: Manuever possible without exceptional piloting strength or skill. No control reversals or PIO. Recovery never in question.

Performance Standards	Target	Desired	Adequate
Maximum bank angle (deg)	0	±5	±10
Pilot Induced Oscillations (PIO)	No PIO	No PIO	Not Divergent

Turning Stall at Idle Power

Flight Phase	MTE	Weather State	Failures
13A. Descent into Class B Airspace	403. Turning Stall at Idle power	1. Light Turb.	0. No Failures

Loading:	7. MFC - Final Cruise condition

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Light/ None	0	Unlimited/ Unlimited	Dry, grooved	N/A

ALT	10,000	EPR	Idle	PSCAS	NORMAL
KEAS/M	155	R/C	Trim	RSCAS	NORMAL
GW	384,862	Vapp	155	A/T	OFF
C.G.	53.2			HUD	ON
GEAR	UP			F/D	OFF
LEF/TEF	Auto			Config	*Ref H Cyc 3*

Abnormals/Exceptions:
None.

Procedure–Evaluation Pilot (PF):
1. Establish a descending 30-degree banked turn.
2. Using pitch inputs to control flight path angle, establish and maintain a smooth deceleration of 1 knot per second.
3. Decelerate to an airspeed which produces approximately 21 degrees angle-of-attack before initiating recovery.
4. Lower the nose and roll wings-level until positive recovery is assured.
5. Terminate the maneuver when recovery is assured (i.e. wings level with AOA less than 13 degrees and steady). No throttle adjustments are allowed.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.
2. Monitor deceleration and call out deviations from the target rate. Verify flaps are automatically extending on schedule.
3. Call out "recover" when angle-of-attack reaches 21 degrees.
4. Verify flaps retract during recovery.
5. Terminate maneuver when recovery is assured (i.e. wings level with AOA less than 13 degrees and steady).

Date: ______ **Pilot:** ______ **Runs:** ______

Evaluation Segment:	Turning Stall	Long CHR	Lat / Dir CHR
Start Evaluation:	30 degree banked turn		
End Evaluation:	Wings level at recovered angle of attack condition		

Evaluation Basis: Manuever possible without exceptional piloting strength or skill. No control reversals or PIO. Recovery never in question.

Performance Standards	Target	Desired	Adequate
Wings level bank angle (deg)	0	±5	±10
Pilot Induced Oscillations (PIO)	No PIO	No PIO	Not Divergent

Turning Stall at Thrust for Level Flight

Flight Phase	MTE	Weather State	Failures
13A. Descent into Class B Airspace	**404.** Turning Stall with Thrust for Level Flight	**1.** Light Turb.	**0.** No Failures

Loading: 7. MFC - Final Cruise condition

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Light/ None	0	Unlimited/ Unlimited	Dry, grooved	N/A

ALT	10,000	**EPR**	Trim	**PSCAS**	NORMAL
KEAS/M	155	**R/C**	0	**RSCAS**	NORMAL
GW	384,862	**Vapp**	155	**A/T**	OFF
C.G.	53.2			**HUD**	ON
GEAR	UP			**F/D**	OFF
LEF/TEF	Auto			**Config**	*Ref H Cyc 3*

Abnormals/Exceptions:
None.

Procedure–Evaluation Pilot (PF):
1. Establish a descending 30-degree banked turn.
2. Using pitch inputs to control flight path angle, establish and maintain a smooth deceleration of 1 knot per second.
3. Decelerate to an airspeed which produces approximately 21 degrees angle-of-attack before initiating recovery.
4. Lower the nose and roll wings-level until positive recovery is assured.
5. Terminate the maneuver when recovery is assured (i.e. wings level with AOA less than 13 degrees and steady). No throttle adjustments are allowed.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.
2. Monitor deceleration and call out deviations from the target rate. Verify flaps are automatically extending on schedule.
3. Call out "recover" when angle-of-attack reaches 21 degrees.
4. Verify flaps retract during recovery.
5. Terminate maneuver when recovery is assured (i.e. wings level with AOA less than 13 degrees and steady).

Date: ____________ **Pilot:** ______________________ **Runs:** ____________

Evaluation Segment:	Turning Stall	Long CHR	Lat / Dir CHR
Start Evaluation:	30 degree banked turn		
End Evaluation:	Wings level at recovered angle of attack condition		

Evaluation Basis: Manuever possible without exceptional piloting strength or skill. No control reversals or PIO. Recovery never in question.

Performance Standards	Target	Desired	Adequate
Wings level bank angle (deg)	0	±5	±10
Pilot Induced Oscillations (PIO)	No PIO	No PIO	Not Divergent

5050

Diving Pull-out

Flight Phase	MTE	Weather State	Failures
7B. Supersonic Cruise	408. Diving Pull-out	1. Light Turb.	0. No Failures
Loading: 6. MCR - Mid Cruise design point, MZFW plus fuel for aft C.G.			

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Light/ None	0	Unlimited/ Unlimited	Dry, grooved	N/A

ALT	64,000	R/C 0	PSCAS	NORMAL	
KEAS/M	M 2.4		RSCAS	NORMAL	
GW	501,324		A/T	OFF	
C.G.	54.8		HUD	ON	
GEAR	UP		F/D	OFF	
LEF/TEF	Auto		Config	*Ref H Cyc 3*	

Abnormals/Exceptions:
None.

Procedure–Evaluation Pilot (PF):
1. Establish straight and level flight on a cardinal heading at the specified airspeed.
2. Establish a -7.5 degree flight path for 20 seconds or until 2.5 M is reached.
3. Execute a 1.5g pullup. Retard throttles to idle.
4. Return to flight within Vmo/Mmo limits. Do not adjust throttle.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.
2. After descent begins, monitor flight path angle to ensure a -7.5 degree descent.
3. Call "recover" at either M 2.5 or 20 seconds, whichever is first reached.
4. Monitor load factor during recovery and provide feedback to PF if necessary to ensure a smooth 1.5g recovery.

Date: ________ **Pilot:** ________ **Runs:** ________

Evaluation Segment: Diving Pullout		Long CHR	Lat / Dir CHR
Start Evaluation:	Straight and Level Flight (Cruise)		
End Evaluation:	Straight Flight at Initial Speed		

Evaluation Basis: Maneuver possible without exceptional piloting strength or skill, and without exceeding VD/MD. No control reversals or PIO.

Performance Standards	Target	Desired	Adequate
Maximum Bank Angle (deg)	0	±5	±10
Maximum load factor during recovery (g)	1.5	1.5±0.2	1.5±0.5

 5060

5070 **Emergency Descent**

Flight Phase	MTE	Weather State	Failures
7A. Supersonic Cruise	411. Emergency Descent	1. Light Turb.	0. No Failures
Loading:	11. MIF - Heavy, Fwd C.G. Limit		

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Light/ None	0	Unlimited/ Unlimited	Dry, grooved	N/A

ALT	55,400	R/C	0	PSCAS	NORMAL
KEAS/M	M 2.4			RSCAS	NORMAL
GW	614,864			A/T	OFF
C.G.	47.2			HUD	ON
GEAR	UP			F/D	OFF
LEF/TEF	Auto			Config	*Ref H Cyc 3*

Abnormals/Exceptions:
Engine Inlets intentionally unstarted during recovery.

Procedure–Evaluation Pilot (PF):
1. Establish straight and level flight at noted airspeed on a cardinal heading.
2. When cabin depressurization is detected, wait 17 seconds, then initiate emergency descent: throttles to idle, drag devices deployed, 45° bank angle. Do not exceed load factor and Vmo limits.
3. Return to level flight at 15,000 ft.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.
2. Monitor descent profile and call envelope excursions.
3. Call out altitudes every 5,000 ft.
4. Call out altitude when passing through 16,000 ft.

Date: ______ **Pilot:** ______ **Runs:** ______

Evaluation Segment: Emergency Descent
Start Evaluation: Straight and level flight (cruise)
End Evaluation: Straight and level flight (low altitude)

Long CHR	Lat / Dir CHR

Evaluation Basis: Evaluate handling qualities during a rapid, maximum speed descent from cruise. Perform maneuver smoothly, with no tendency to oscillate or hunt for pitch attitude or speed throughout the maneuver.

Performance Standards	Target	Desired	Adequate
Normal Acceleration (g)	1	1.0±0.5	0/+2.0
Airspeed above Vmo (kt)	0	0	25

6050 **Inadvertent Speed Increase**

Flight Phase	MTE	Weather State	Failures
7C. Supersonic Cruise	504. Inadvertent Speed Increase, High Speed	1. Light Turb.	0. No Failures

Loading: 7. MFC - Final Cruise condition

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Light/ None	0	Unlimited/ Unlimited	Dry, grooved	N/A

ALT	64,000	R/C	0	PSCAS	NORMAL
KEAS/M	M 2.4			RSCAS	NORMAL
GW	384,862			A/T	OFF
C.G.	53.2			HUD	ON
GEAR	UP			F/D	OFF
LEF/TEF	Auto			Config	*Ref H Cyc 3*

Abnormals/Exceptions:
None.

Procedure–Evaluation Pilot (PF):
1. Establish straight and level flight at M 2.4.
2. Push over to 0.7g load factor for 5 seconds.
3. Initiate a 1.5 g pullup recovery to level flight.
4. Terminate maneuver when level flight has been established.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.
2. Monitor load factor and call out when deviations exceed 0.1 g from target.

Date: ________ **Pilot:** ________ **Runs:** ________

Evaluation Segment: Inadvertent Speed Increase (high speed)
Start Evaluation: Straight and Level Flight (Cruise)
End Evaluation: Straight and Level Flight

Long CHR	Lat / Dir CHR

Evaluation Basis: Maneuver is possible without exceptional piloting strength or skill and without exceeding Md.

Performance Standards	Target	Desired	Adequate
Maximum Bank Angle (deg)	0	±5	±10
Maximum load factor during recovery (g)	1.5	1.5±0.2	1.5±0.5
Maximum Mach	<2.6	<2.6	<2.6

6060 **2-Axis Upset**

Flight Phase	MTE	Weather State	Failures
7C. Supersonic Cruise	505. Simulated 2-Axis Gust Upset, High Speed	1. Light Turb.	0. No Failures

Loading: 7. MFC - Final Cruise condition

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Light/ None	0	Unlimited/ Unlimited	Dry, grooved	N/A

ALT	64,000	R/C	0	PSCAS	NORMAL
KEAS/M	M 2.4			RSCAS	NORMAL
GW	384,862			A/T	OFF
C.G.	53.2			HUD	ON
GEAR	UP			F/D	OFF
LEF/TEF	Auto			Config	*Ref H Cyc 3*

Abnormals/Exceptions:
None.

Procedure–Evaluation Pilot (PF):
1. Establish straight and level flight at M 2.4.
2. Reduce throttle to 50% and pull up gently to decelerate to M 2.3.
3. Establish a flight path angle of 6 degrees below the horizon, then roll to a bank angle of 15 degrees.
4. Maintain this attitude for 3 seconds.
5. Roll wings level.
6. Execute a 1.5 g pull-up to recover to level flight. Advance throttles to full to begin acceleration.
7. Terminate the maneuver after all transients have quiesed.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.
2. Count off 3 seconds after reaching M 2.4 and call out "Recover."
3. Monitor load factor during recovery and provide feedback to PF if necessary to ensure a smooth 1.5 g recovery.

Date: ____________ **Pilot:** ____________ **Runs:** ____________

Evaluation Segment: 2-axis Upset
Start Evaluation: Straight and Level Flight (Cruise)
End Evaluation: Straight Flight

Long CHR	Lat / Dir CHR

Evaluation Basis: Maneuver is possible without exceptional piloting strength or skill and without exceeding Md.

Performance Standards	Target	Desired	Adequate
Maximum Bank Angle (deg)	15	±5	±10
Maximum load factor during recovery (g)	1.5	1.5±0.2	1.5±0.5

VMCG

Date: ____________ Pilot: ______________________ Runs: __________

Flight Phase	MTE	Weather State	Failures
2A. Takeoff	602. VMCG	1. Light Turb.	60. Single Engine Failure

Loading: 14. M3A - MZFW+Body Fuel+Wing Fuel, Aft C.G.

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Light/ None	0	Unlimited/ Unlimited	Dry, grooved	End of runway, on centerline.

ALT	Field	V1	TBD	PSCAS	NORMAL
KEAS/M	0	Vr	127	RSCAS	NORMAL
GW	384,862	Vlo	139	A/T	OFF
C.G.	54	V2	TBD	HUD	ON
GEAR	DOWN	V2+10	TBD	F/D	OFF
LEF/TEF	30/10	Vmcg	127	Config	*Ref H Cyc 3*

Abnormals/Exceptions:
No nosewheel cornering force above 80 knots. Fail #4 engine at Vmcg.

Procedure–Evaluation Pilot (PF):
1. Set brakes.
2. Advance throttles to takeoff EPR.
3. Release the brakes and maintain centerline during ground roll. PNF will make airspeed call-outs and monitor engine performance.
4. When engine fails, maintain runway centerline with rudder control only, minimizing deviation.
5. Terminate maneuver after recovery from maximum centerline deviation has been accomplished.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.
2. Make airspeed call-outs at 100 knots, V1, and Vr.
3. Remove nose gear cornering force at approximately 80 knots.
4. At Vmcg, fail the outboard engine and call out "Engine 4 Failed."
5. Note maximum centerline deviation.

Evaluation Segment: Minimum Control Speed - Ground
Start Evaluation: At Vmcg on runway centerline
End Evaluation: After recovery from maximum deviation from runway centerline has been accomplished.

Long CHR	Lat / Dir CHR

Evaluation Basis: Evaluate maximum runway centerline deviation.

Performance Standards	Target	Desired	Adequate
Maximum runway centerline deviation (ft)	<30	<30	<30

One Engine Out Takeoff

Flight Phase	MTE	Weather State	Failures
2A. Takeoff	103. One engine out takeoff	1. Light Turb.	60. Single Engine Failure

Loading: 3. M13 - Max Taxi Weight @ fwd C.G., full aft fuselage fuel, partial wing fuel, max payload

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Light/ None	0	Unlimited/ Unlimited	Dry, grooved	End of runway, on centerline.

ALT	Field	V1	170	PSCAS	NORMAL
KEAS/M	0	Vr	186	RSCAS	NORMAL
GW	649,914	Vlo	200	A/T	OFF
C.G.	48.1	• V2	202	HUD	ON
GEAR	DOWN	V2+10	215	F/D	TO speed
LEF/TEF	Auto	Vmin	181	Config	*Ref H Cyc 3*

Abnormals/Exceptions:
None.

Procedure–Evaluation Pilot (PF):
1. Set brakes.
2. Advance throttles to takeoff EPR.
3. Release the brakes and maintain centerline during ground roll. PNF will make airspeed call-outs and monitor engine performance.
4. At rotation speed (Vr), initiate rotation to follow rotation rate pitch guidance indicators. Utilize HUD guidance to preclude tail-strikes.
5. At positive climb-rate, call "gear up". Follow velocity vector guidance symbol to intercept and maintain speed and extended runway centerline.
6. Terminate the maneuver at 6.0 DME and in stable climb at V2+10.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.
2. Make airspeed call-outs at 100 knots, V1, and Vr.
3. Immediately after reaching V1, call "Engine # Failed, continue takeoff".
4. Move gear handle to gear-up position when requested by PF.
5. Terminate the maneuver at 6.0 DME and in stable climb at V2+10.

Date: ________ **Pilot:** ________ **Runs:** ________

Evaluation Segment: Takeoff Roll, Rotation & Initial Climb Out - PLR	Long CHR	Lat / Dir CHR
Start Evaluation: Stopped on Runway End Evaluation: Just prior to second EPR cutback		

Evaluation Basis: The pilot is to evaluate the ease of tracking the runway centerline with rudder pedals alone as the aircraft accelerates during the takeoff roll. The pilot is to evaluate the control of the rotation and capability to track the pitch rate guidance indicators, and the ability to follow velocity-vector guidance once airborne. No PIO is allowed. No geometry strikes are allowed.

Performance Standards	Target	Desired	Adequate
Runway Centerline Deviation, on ground (ft)	0	±10	±27
Rotation Pitch Rate Contol, on ground (deg)	generated	<±0.5 bracket 90% of time (±0.6 deg/s)	<±1 bracket 90% of time (±1.2 deg/s)
Longitudinal velocity vector control, airborne (de)	generated	<±1 V-vector height 90% of time	<±2 V-vector height 90% of time
Lateral velocity vector control, airborne (deg)	generated	<±1 V-vector width 90% of time	<±2 V-vector width 90% of time
Bank Angle Control, airborne (deg)	0	±5	±10
Runway Heading Deviation, airborne (deg)	0	±2	±4

7035

One Engine Out Takeoff in Crosswind

Flight Phase	MTE	Weather State	Failures
2A. Takeoff	100. Standard Acoustic Takeoff	33. 35 Kt Crosswind	60. Single Engine Failure

Loading: 3. M13 - Max Taxi Weight @ fwd C.G., full aft fuselage fuel, partial wing fuel, max payload

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 35 Kt	Light/ None	0	Unlimited/ Unlimited	Dry, grooved	End of runway, on centerline.

ALT	Field	**V1**	170	**PSCAS**	NORMAL
KEAS/M	0	**Vr**	186	**RSCAS**	NORMAL
GW	649,914	**Vlo**	200	**A/T**	OFF
C.G.	48.1	**V2**	202	**HUD**	ON
GEAR	DOWN	**V2+10**	215	**F/D**	TO speed
LEF/TEF	Auto	**Vmin**	181	**Config**	*Ref H Cyc 3*

Abnormals/Exceptions:
None.

Procedure–Evaluation Pilot (PF):
1. Set brakes.
2. Advance throttles to takeoff EPR.
3. Release the brakes and maintain centerline during ground roll. PNF will make airspeed call-outs and monitor engine performance.
4. At rotation speed (Vr), initiate rotation to follow rotation rate pitch guidance indicators. Utilize HUD guidance to preclude tail-strikes.
5. At positive climb-rate, call "gear up". Follow velocity vector guidance symbol to intercept and maintain speed and extended runway centerline.
6. Terminate the maneuver at 6.0 DME and in stable climb at V2+10.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.
2. Make airspeed call-outs at 100 knots, V1, and Vr.
3. Immediately after reaching V1, call "Engine # Failed, continue takeoff".
4. Move gear handle to gear-up position when requested by PF.
5. Terminate the maneuver at 6.0 DME and in stable climb at V2+10.

Date: ____________ **Pilot:** ____________________ **Runs:** ________

		Long CHR	Lat / Dir CHR
Evaluation Segment:	Takeoff Roll, Rotation & Initial Climb Out - PLR		
Start Evaluation:	Stopped on Runway		
End Evaluation:	Just prior to second EPR cutback		

Evaluation Basis: The pilot is to evaluate the ease of tracking the runway centerline with rudder pedals alone as the aircraft accelerates during the takeoff roll. The pilot is to evaluate the control of the rotation and capability to track the pitch rate guidance indicators, and the ability to follow velocity-vector guidance once airborne. No PIO is allowed. No geometry strikes are allowed.

Performance Standards	Target	Desired	Adequate
Runway Centerline Deviation, on ground (ft)	0	±10	±27
Rotation Pitch Rate Contol, on ground (deg)	generated	<±0.5 bracket 90% of time (±0.6 deg/s)	<±1 bracket 90% of time (±1.2 deg/s)
Longitudinal velocity vector control, airborne (de)	generated	<±1 V-vector height 90% of time	<±2 V-vector height 90% of time
Lateral velocity vector control, airborne (deg)	generated	<±1 V-vector width 90% of time	<±2 V-vector width 90% of time
Bank Angle Control, airborne (deg)	0	±5	±10
Runway Heading Deviation, airborne (deg)	0	±2	±4

7040 Minimum Control Airspeed - Air

Flight Phase	MTE	Weather State	Failures
3A. Class B Airspace Climb	604. Dynamic VMCA	1. Light Turb.	60. Single Engine Failure

Loading: 7. MFC - Final Cruise condition

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Light/ None	0	Unlimited/ Unlimited	Dry, grooved	End of runway, on centerline.

ALT	Field	R/C	0	PSCAS	NORMAL
KEAS/M	0	V1	120	RSCAS	NORMAL
GW	384,862	Vr	130	A/T	OFF
C.G.	53.2	Vmca	120	HUD	ON
GEAR	DOWN			F/D	OFF
LEF/TEF	Auto			Config	*Ref H Cyc 3*

Abnormals/Exceptions:
Outboard engine failure

Procedure–Evaluation Pilot (PF):
1. Set brakes.
2. Advance throttles to takeoff EPR.
3. Release brakes and perform normal takeoff maneuver.
4. Call "Gear Up" at 50 ft altitude call.
5. Pitch up to 30-35 degree pitch attitude at full throttle; allow airspeed to decay slowly to target Vmca.
6. When engine fails, lower velocity vector to maintain Vmca and maintain runway heading with rudder control, minimizing heading deviation.
7. Trim for zero sideslip angle using wing-low technique
8. Terminate maneuver when steady-state conditions are achieved.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.
2. Make airspeed call-outs at 100 knots, V1, and Vr.
3. Raise gear at PF call.
4. At Vmca, fail an outboard engine via fuel cutoff. Call out "Engine 4 Failed."
5. Call out heading and airspeed values.

Date: ____________ **Pilot:** ______________________ **Runs:** ____________

Evaluation Segment: Minimum Control Speed - Air	Long CHR	Lat / Dir CHR
Start Evaluation: At engine failure End Evaluation: at steady-state flight		

Evaluation Basis: Evaluate handling qualities during a dynamic failure of an outboard engine at low speed. Demonstrate ability to recover from engine failure and maintain Vmca airspeed without exceeding 20 degrees of heading change during the maneuvernor more than 5 degrees of bank angle at steady-state trim.

Performance Standards	Target	Desired	Adequate
Maximum heading deviation (deg)	0	±10	±20
Maximum bank angle deviation (deg)	0	<5	<10
Deviation in Airspeed	0	±5	±10

Dynamic VMCL-2

Flight Phase	MTE	Weather State	Failures
16A. Final Approach	606. Dynamic VMCL-2	1. Light Turb.	61. Second Engine Failure
Loading: 7. MFC - Final Cruise condition			

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Light/ None	0	Unlimited/ Unlimited	Dry, grooved	On G/S and LOC, after OM

ALT	1,500	Vapp	TBD	PSCAS	NORMAL
KEAS/M	TBD	Vref	154	RSCAS	NORMAL
GW	384,862	Vg/a	TBD	A/T	OFF
C.G.	53.2	Vmin	125	HUD	ON
GEAR	DOWN			F/D	OFF
LEF/TEF	Auto			Config	*Ref H Cyc 3*

Abnormals/Exceptions:
One inboard engine inop

Procedure–Evaluation Pilot (PF):
1. Maintain a 3 degree glideslope at Vapp with zero bank angle and one inboard engine inop.
2. When the outboard engine fails, advance two remaining engines as required to maintain approach speed.
3. Maintain airspeed, minimize course deviation.
4. Recover to nominal course and speed. Maintain airspeed. Restrict new trim bank angle to no greater than 5 degrees.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.
2. When stabilized on 3 degree glideslope, fail the outboard engine on the same wing as the inop inboard engine via fuel shutoff. Call out "Engine X Failed."
3. Call out airspeed deviations.

Date: ____________ **Pilot:** ____________________ **Runs:** ____________

		Long CHR	Lat / Dir CHR
Evaluation Segment:	Minimum Control Speed - Landing Config, Two engines out		
Start Evaluation:	Landing Approach		
End Evaluation:	Stabilized on Constant Heading		

Evaluation Basis: Evaluate handling qualities during a dynamic failure of two engines on the same wing with full asymmetric thrust. Demonstrate ability to recover from second engine failure at approach speeds as slow as 140 knots.

Performance Standards	Target	Desired	Adequate
Maximum heading deviation (deg)	0	±10	±20
Maximum bank angle deviation (deg)	0	<5	<10
Deviation in Airspeed	0	±5	±10

7050

Ripple Unstart

Flight Phase	MTE	Weather State	Failures
7C. Supersonic Cruise	610. Ripple Unstart	1. Light Turb.	63. Ripple Unstart
Loading: 7. MFC - Final Cruise condition			

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Light/ None	0	Unlimited/ Unlimited	Dry, grooved	N/A

ALT	64,000	EPR	Trim	PSCAS	NORMAL
KEAS/M	M 2.4	R/C	0	RSCAS	NORMAL
GW	384,862			A/T	OFF
C.G.	53.2			HUD	ON
GEAR	UP			F/D	OFF
LEF/TEF	Auto			Config	*Ref H Cyc 3*

Abnormals/Exceptions:
One inboard engine inop

Procedure–Evaluation Pilot (PF):
1. Establish straight and level flight at stated conditions on a cardinal heading.
2. Upon hearing "Recover," recover to straight and level flight and maintain assigned altitude. Use rudder to correct for yaw deviations. A small steady-state bank angle is acceptable.
3. Upon hearing "Engine X Failed," retard the appropriate throttle to idle.
4. Terminate when in steady level decelerating flight with little or no sideslip.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.
2. At an appropriate time, command an inboard engine inlet unstart, coupled with an engine failure. Immediately following,unstart theoutboard inlet on the same side.
3. Immediately call out "Recover."
4. As soon as cockpit indications detect symptoms of the engine failure, call out "Engine X Failed."
5. Verify, if possible, that both inlets automatically restart within one seconds.
6. Verify that the PDF has retarded the throttle on the failed engine and that the engine remains windmilling.

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Date: ____________ **Pilot:** ____________________ **Runs:** ____________

Evaluation Segment:	Inlet Unstart	Long CHR	Lat / Dir CHR
Start Evaluation:	Straight and Level Flight		
End Evaluation:	Straight Flight (Descent)		

Evaluation Basis: Evaluate handling qualities during recovery from an upset induced by one or more inlet unstarts coupled with an engine failure. Perform maneuver quickly and smoothly, with no tendency to oscillate or hunt for bank angle and pitch attitude throughout the maneuver.

Performance Standards	Target	Desired	Adequate
Max. Load Factor Deviation in Recovery (g)	0	±0.1	±0.3
Maximum Bank Angle (deg)	0	±10	±20
Deviation from Initial Heading (deg)	0	±5	±10

Engine-out Stall

Flight Phase	MTE	Weather State	Failures
4B. Subsonic Climb	607. Engine-out Stall	1. Light Turb.	60. Single Engine Failure

Loading: 7. MFC - Final Cruise condition

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Light/ None	0	Unlimited/ Unlimited	Dry, grooved	N/A

ALT	10,000	R/C	Trim	PSCAS	NORMAL
KEAS/M	155	Thrust	75%	RSCAS	NORMAL
GW	384,862			A/T	OFF
C.G.	53.2			HUD	ON
GEAR	UP			F/D	OFF
LEF/TEF	Auto			Config	*Ref H Cyc 3*

Abnormals/Exceptions:
One outboard engine inop

Procedure–Evaluation Pilot (PF):
1. Establish straight climbing flight at the indicated conditions on a cardinal heading with zero sideslip.
2. Using pitch inputs to control flight path angle, establish and maintain a smooth deceleration of 1 knot per second.
3. Decelerate to an airspeed which produces approximately 21 degrees angle-of-attack before initiating recovery.
4. At recovery, lower the nose and maintain wings-level.
5. Terminate the maneuver when recovery is assured (i.e. wings level with AOA less than 13 degrees and steady). No throttle adjustments are allowed.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.
2. Monitor deceleration and call out deviations from the target rate. Verify flaps are automatically extending on schedule.
3. Call out "recover" when angle-of-attack reaches 21 degrees.
4. Verify flaps retract during recovery.
5. Terminate maneuver when recovery is assured (i.e. wings level with AOA less than 13 degrees and steady).

Date: ____________ **Pilot:** ______________________ **Runs:** __________

Evaluation Segment: Stall
Start Evaluation: Steady flight, wings level
End Evaluation: Wings level at recovered angle of attack condition

Long CHR	Lat / Dir CHR

Evaluation Basis: Manuever possible without exceptional piloting strength or skill. No control reversals or PIO. Recovery never in question.

Performance Standards	Target	Desired	Adequate
Maximum bank angle (deg)	0	±5	±10
Pilot Induced Oscillations (PIO)	No PIO	No PIO	Not Divergent

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Engine-out Turning Stall

Flight Phase	MTE	Weather State	Failures
4B. Subsonic Climb	608. Engine-out Turning Stall	1. Light Turb.	60. Single Engine Failure

Loading: 7. MFC - Final Cruise condition

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Light/ None	0	Unlimited/ Unlimited	Dry, grooved	N/A

ALT	10,000	R/C	Trim	PSCAS	NORMAL
KEAS/M	155	Thrust	75%	RSCAS	NORMAL
GW	384,862			A/T	OFF
C.G.	53.2			HUD	ON
GEAR	UP			F/D	OFF
LEF/TEF	Auto			Config	*Ref H Cyc 3*

Abnormals/Exceptions:
One outboard engine inop

Procedure–Evaluation Pilot (PF):
1. Establish straight climbing flight at the indicated conditions, then roll the airplane into a 30 degree bank into the failed engine.
2. Using pitch inputs to control flight path angle, establish and maintain a smooth deceleration of 1 knot per second.
3. Decelerate to 21 degrees angle-of-attack.
4. Apply forward control until positive recovery is assured.
5. Terminate the maneuver when recovery is assured (i.e. wings level with AOA less than 13 degrees and steady). No throttle adjustments are allowed.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.
2. Monitor deceleration and call out deviations from the target rate. Verify flaps are automatically extending on schedule.
3. Call out "recover" when angle-of-attack reaches 21 degrees.
4. Verify flaps retract during recovery.
5. Terminate maneuver when recovery is assured (i.e. wings level with AOA less than 13 degrees and steady).

Date: ____________ **Pilot:** ____________________ **Runs:** ____________

Evaluation Segment: Turning Stall
Start Evaluation: 30 degree banked turn
End Evaluation: Wings level at recovered angle of attack condition

Long CHR	Lat / Dir CHR

Evaluation Basis: Manuever possible without exceptional piloting strength or skill. No control reversals or PIO. Recovery never in question.

Performance Standards	Target	Desired	Adequate
Wings level bank angle (deg)	0	±5	±10
Pilot Induced Oscillations (PIO)	No PIO	No PIO	Not Divergent

Manual Thrust Landing

Flight Phase	MTE	Weather State	Failures
15A. Initial Approach Fix	313. Complete Approach and Landing	1. Light Turb.	0. Autothrottle Failed

Loading: 7. MFC - Final Cruise condition

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Light/ None	0	Unlimited/ Unlimited	Dry, grooved	3 nm from threshold, on LOC.

ALT	1,500 AGL	Vapp	159	PSCAS	NORMAL
KEAS/M	190	Vref	154	RSCAS	NORMAL
GW	384,862	Vg/a	159	A/T	OFF
C.G.	53.2	Vmin	125	HUD	ON
GEAR	UP			F/D	OFF
LEF/TEF	Auto			Config	*Ref H Cyc 3*

Abnormals/Exceptions:
None.

Procedure–Evaluation Pilot (PF):
1. Establish aircraft in steady level flight at the noted conditions, tracking LOC.
2. Slow to Vapp when instructed by PNF.
3. Capture G/S. Track LOC and G/S using HUD or PFD.
4. Manually retard throttles and execute a flare to touchdown at the target point on the runway.
5. After touchdown, retard throttles to idle and lower the nosewheel to the runway.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.
2. When DME reads 7.0, instruct PF to decelerate to Vapp.
3. 1/2 dot before G/S capture, call out "Gear Down" and move gear handle to down position.

Date: ____________ **Pilot:** ____________________ **Runs:** ____________

Evaluation Segment: Glideslope Intercept
Start Evaluation: 1,500 ft, Final Approach Speed, Level
End Evaluation: 200 ft AGL, Landing Speed, Descending

Long CHR	Lat / Dir CHR

Evaluation Basis: Evaluate the ability to rapidly maneuver onto the final approach path at low altitudes. Attained trimmed flight before the middle marker (approximately 0.5 nm from the end of the runway).

Performance Standards	Target	Desired	Adequate
Dev. from Final Appr. Airspeed (KEAS)	Vapp	±5	±10
Deviation from Glideslope (dots)	0	±0.5	±1.0
Deviation from Localizer (dots)	0	±0.5	±1.0

Evaluation Segment: Precision Landing
Start Evaluation: 200 ft AGL, Landing Speed, Descending
End Evaluation: Nosewheel touchdown

Long CHR	Lat / Dir CHR

Evaluation Basis: Evaluate handling qualities in landing. For desired performance, there should be no tendency to PIO or bobble in pitch or roll. There should also be no tendency to float or bounce after touchdown.There should be no geometry strikes on touchdown.

Performance Standards	Target	Desired	Adequate
Deviation from Approach Airspeed at 50 ft (kt)	0	±5	±10
Deviation from Runway Heading at touchdown (deg)	0	±3	±6
Longitudinal distance from threshold at touchdown (ft)	1250	1000-1500	750-2250
Lateral offset from runway centerline at touchdown (ft)	0	±10	±27
Sink Rate at touchdown (ft/sec)	<1	≤4	≤7
Maximum Bank Angle below 50 ft AGL (deg)	0	±5	±7
Pilot Induced Oscillations (PIO)	No PIO	No PIO	Not Divergent
Geometry Strikes (tail, engine nacelle, wing tip)	No Strikes	No Strikes	No Strikes

Unaugmented Landing

Flight Phase	MTE	Weather State	Failures
15A. Initial Approach Fix	313. Complete Approach and Landing	1. Light Turb.	80. Direct Electrical Link reversion

Loading: 7. MFC - Final Cruise condition

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Light/ None	0	Unlimited/ Unlimited	Dry, grooved	3 nm outside OM, 4,500 ft right of runway centerline, on 30 degree intercept course.

ALT	1,500 AGL	Vman	125	PSCAS	DEL
KEAS/M	190	Vapp	159	RSCAS	DEL
GW	384,862	Vref	154	A/T	OFF
C.G.	53.2	Vg/a	159	HUD	ON
GEAR	UP	Vmin	125	F/D	OFF
LEF/TEF	Auto			Config	*Ref H Cyc 3*

Abnormals/Exceptions:
All Controls Manual.

Procedure–Evaluation Pilot (PF):
1. Establish aircraft in steady level flight at the noted conditions, tracking LOC.
2. Slow to Vapp when instructed by PNF.
3. Capture G/S. Track LOC and G/S using HUD.
4. Disconnect autothrottles at 50 ft AGL.
5. Manually retard throttles and execute a flare to touchdown at the target point on the runway.
6. After touchdown, retard throttles to idle and lower the nosewheel to the runway.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.
2. When DME reads 7.0, instruct PF to decelerate to Vapp.
3. 1/2 dot before G/S capture, call out "Gear Down" and move gear handle to down position.

Date: ____________ **Pilot:** ____________________ **Runs:** __________

Evaluation Segment: Glideslope and Localizer Intercept
Start Evaluation: 1,500 ft, Final Approach Speed, Level
End Evaluation: 200 ft AGL, Landing Speed, Descending

Long CHR	Lat / Dir CHR

Evaluation Basis: Evaluate the ability to accurately maneuver onto the final approach path and maintain nominal approach profile and speed at low altitudes. Attained trimmed flight before the middle marker (approximately 0.5 nm from the end of the runway).

Performance Standards	Target	Desired	Adequate
Deviation from Final Approach Airspeed (kt)	0	±5	±10
Deviation from Glideslope (dots)	0	±0.5	±1.0
Deviation from Localizer (dots)	0	±0.5	±1.0

Evaluation Segment: Precision Landing
Start Evaluation: 200 ft AGL, Landing Speed, Descending
End Evaluation: Nosewheel touchdown

Long CHR	Lat / Dir CHR

Evaluation Basis: Evaluate handling qualities in landing. For desired performance, there should be no tendency to PIO or bobble in pitch or roll. There should also be no tendency to float or bounce after touchdown.There should be no geometry strikes on touchdown.

Performance Standards	Target	Desired	Adequate
Deviation from Approach Airspeed at 50 ft (kt)	0	±5	±10
Deviation from Runway Heading at touchdown (deg)	0	±3	±6
Longitudinal distance from threshold at touchdown (ft)	1250	1000-1500	750-2250
Lateral offset from runway centerline at touchdown (ft)	0	±10	±27
Sink Rate at touchdown (ft/sec)	<1	≤4	≤7
Maximum Bank Angle below 50 ft AGL (deg)	0	±5	±7
Pilot Induced Oscillations (PIO)	No PIO	No PIO	Not Divergent
Geometry Strikes (tail, engine nacelle, wing tip)	No Strikes	No Strikes	No Strikes

7100

Standard Acoustic Takeoff/Flaperon Hardover

Flight Phase	MTE	Weather State	Failures
2A. Takeoff	100. Standard Acoustic Takeoff	1. Light Turb.	112. Two aileron Panels (Asymmetric)
Loading: 3. M13 - Max Taxi Weight @ fwd C.G., full aft fuselage fuel, partial wing fuel, max payload			

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Light/ None	0	Unlimited/ Unlimited	Dry, grooved	End of Runway on Centerline

ALT	Field	V1	166	PSCAS	NORMAL
KEAS/M	0	Vr	186	RSCAS	NORMAL
GW	649,914	VLO	200	A/T	ON
C.G.	48.1	V2	202	HUD	ON
GEAR	DOWN	V2+10	212	F/D	OFF
LEF/TEF	30/10			Config	*Ref H Cyc 3*

Abnormals/Exceptions:
Flaperon Hardover after rotation.

Note: This maneuver is to be performed with the leading- and trailing-edge flaps fixed to 30/10 degrees.

Procedure–Evaluation Pilot (PF):
1. Set brakes.
2. Advance throttles to takeoff EPR.
3. Release the brakes and maintain centerline during ground roll. PNF will make airspeed call-outs and monitor engine performance.
4. At rotation speed (Vr), initiate rotation to follow rotation rate pitch guidance indicators. Utilize HUD guidance to preclude tail-strikes.
5. At positive climb-rate, call "gear up". Follow velocity vector guidance symbol to intercept and maintain speed and extended runway centerline.
6. When established at V2+10, PNF takes control of the throttles.
7. Maintain target climb airspeed and runway heading throughtout cutback maneuver.
8. Terminate maneuver at 8.0 DME to record data for acoustic calculations.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.
2. Make airspeed call-outs at 100 knots, V1, and Vr.
3. Call out "flaperon hardover".
4. Move gear handle to gear-up position, when requested by PF.
5. Monitor gear retraction and automatic device retraction.
6. Make altitude call-outs at 500 and 600 feet. At 700 feet, call "cutback" and manually retard throttles to cutback EPR (56%) over an approximately 7 second interval.
7. Maintain cutback condition until 8.0 DME for acoustic calculations.

Date: ____________ **Pilot:** ____________________ **Runs:** __________

Evaluation Segment: Rotation & Initial Climb Out	Long CHR	Lat / Dir CHR
Start Evaluation: Vr End Evaluation: Just prior to EPR cutback		

Evaluation Basis: The pilot is to evaluate the ability to rotate promptly (without tail strike), liftoff, and capture the target climb speed.

Performance Standards	Target	Desired	Adequate
Rotation pitch attitude (deg)	10	10±0.5	10±1
Deviation from climb speed (kt)	0	±5	±10
Overshoot of max allowable pitch attitude (deg)	0	<1	<2
Bank Angle Control (deg)	0	±5	±10
Runway Heading Deviation (deg)	0	±2	±4
Pilot Induced Oscillations (PIO)	No PIO	No PIO	Not Divergent
Geometry Strikes (tail, engine nacelle, wing tip)	No Strikes	No Strikes	No Strikes

7212 Standard Acoustic Takeoff/Elevator Hardover (TE Down)

Flight Phase	MTE	Weather State	Failures
2A. Takeoff	100. Standard Acoustic Takeoff	1. Light Turb.	111. Both elevator panels

Loading: 3. M13 - Max Taxi Weight @ fwd C.G., full aft fuselage fuel, partial wing fuel, max payload

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Light/ None	0	Unlimited/ Unlimited	Dry, grooved	End of Runway on Centerline

ALT	Field	V1	166	PSCAS	NORMAL
KEAS/M	0	Vr	186	RSCAS	NORMAL
GW	649,914	VLO	200	A/T	ON
C.G.	48.1	V2	202	HUD	ON
GEAR	DOWN	V2+10	212	F/D	OFF
LEF/TEF	30/10			Config	*Ref H Cyc 3*

Abnormals/Exceptions:
Elevator Hardover (TE Down) after takeoff.

Note: This maneuver is to be performed with the leading- and trailing-edge flaps fixed to 30/10 degrees.

Procedure–Evaluation Pilot (PF):
1. Set brakes.
2. Advance throttles to takeoff EPR.
3. Release the brakes and maintain centerline during ground roll. PNF will make airspeed call-outs and monitor engine performance.
4. At rotation speed (Vr), initiate rotation to follow rotation rate pitch guidance indicators. Utilize HUD guidance to preclude tail-strikes.
5. At positive climb-rate, call "gear up". Follow velocity vector guidance symbol to intercept and maintain speed and extended runway centerline.
6. PF calls "flaps up" after failure
7. When established at V2+10, PNF takes control of the throttles.
8. Maintain target climb airspeed and runway heading throughtout cutback maneuver.
9. Terminate maneuver at 8.0 DME to record data for acoustic calculations.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.
2. Make airspeed call-outs at 100 knots, V1, and Vr.
3. Move gear handle to gear-up position, when requested by PF.
4. Monitor gear retraction and automatic device retraction.
5. Call out "elevator hardover".
6. Retract flaps when requested by PF.
7. Make altitude call-outs at 500 and 600 feet. At 700 feet, call "cutback" and manually retard throttles to cutback EPR (56%) over an approximately 7 second interval.
8. Maintain cutback condition until 8.0 DME for acoustic calculations.

Date: ____________ **Pilot:** ____________________ **Runs:** ____________

Evaluation Segment: Rotation & Initial Climb Out
Start Evaluation: Vr
End Evaluation: Just prior to EPR cutback

Long CHR	Lat / Dir CHR

Evaluation Basis: The pilot is to evaluate the ability to rotate promptly (without tail strike), liftoff, and capture the target climb speed.

Performance Standards	Target	Desired	Adequate
Rotation pitch attitude (deg)	10	10±0.5	10±1
Deviation from climb speed (kt)	0	±5	±10
Overshoot of max allowable pitch attitude (deg)	0	<1	<2
Bank Angle Control (deg)	0	±5	±10
Runway Heading Deviation (deg)	0	±2	±4
Pilot Induced Oscillations (PIO)	No PIO	No PIO	Not Divergent
Geometry Strikes (tail, engine nacelle, wing tip)	No Strikes	No Strikes	No Strikes

7252 Precision Landing/Elevator Hardover (TE Down)

Flight Phase	MTE	Weather State	Failures
17A. Landing	303. Precision Landing	1. Light Turb.	111. Both elevator panels
Loading: 7. MFC - Final Cruise condition			

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Light/ None	0	Unlimited/ Unlimited	Dry, grooved	400 ft AGL; On LOC & G/S

ALT	400 AGL	Vapp	159	PSCAS	NORMAL
KEAS/M	157	Vref	154	RSCAS	NORMAL
GW	384,862	Vg/a	159	A/T	ON
C.G.	53.2	Vmin	125	HUD	ON
GEAR	DOWN			F/D	OFF
LEF/TEF	Auto			Config	*Ref H Cyc 3*

Abnormals/Exceptions:
Elevator Hardover (TE Down) during approach.

Procedure–Evaluation Pilot (PF):
1. PF establishes aircraft in steady descending flight at the noted conditions.
2. PF tracks G/S and LOC using HUD.
3. PF calls "reset flaps" after failure.
4. At appropriate altitude, PF maneuvers to touchdown on the aim point on runway with a normal flare and landing.
5. After touchdown, lower the nosewheel to the runway while retarding thrust to idle.
6. After nosewheel touchdown, apply normal braking until below 80 knots, maintaining runway centerline.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.
2. Call out elevator hardover.
3. Reset flaps to TOGA deflection (30/10) when requested by PF.

Date: ______ **Pilot:** ______ **Runs:** ______

Evaluation Segment: Precision Landing	Long CHR	Lat / Dir CHR
Start Evaluation: 200 ft AGL, Landing Speed, Descending End Evaluation: Nosewheel touchdown		

Evaluation Basis: Evaluate handling qualities in landing. For desired performance, there should be no tendency to PIO or bobble in pitch or roll. There should also be no tendency to float or bounce after touchdown.There should be no geometry strikes on touchdown.

Performance Standards	Target	Desired	Adequate
Deviation from Approach Airspeed at 50 ft (kt)	0	±5	±10
Deviation from Runway Heading at touchdown (deg)	0	±3	±6
Longitudinal distance from threshold at touchdown (ft)	1250	1000-1500	750-2250
Lateral offset from runway centerline at touchdown (ft)	0	±10	±27
Sink Rate at touchdown (ft/sec)	<1	≤4	≤7
Maximum Bank Angle below 50 ft AGL (deg)	0	±5	±7
Pilot Induced Oscillations (PIO)	No PIO	No PIO	Not Divergent
Geometry Strikes (tail, engine nacelle, wing tip)	No Strikes	No Strikes	No Strikes

Precision Landing/Rudder Hardover

Flight Phase	MTE	Weather State	Failures
17A. Landing	303. Precision Landing	1. Light Turb.	42. One Rudder Panel Hardover

Loading: 7. MFC - Final Cruise condition

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Light/ None	0	Unlimited/ Unlimited	Dry, grooved	400 ft AGL; On LOC & G/S

ALT	400 AGL	Vapp	159	PSCAS	NORMAL
KEAS/M	157	Vref	154	RSCAS	NORMAL
GW	384,862	Vg/a	159	A/T	ON
C.G.	53.2	Vmin	125	HUD	ON
GEAR	DOWN			F/D	OFF
LEF/TEF	Auto			Config	*Ref H Cyc 3*

Abnormals/Exceptions:
Rudder Hardover during approach.

Procedure–Evaluation Pilot (PF):
1. PF establishes aircraft in steady descending flight at the noted conditions.
2. PF tracks G/S and LOC using HUD.
3. At appropriate altitude, PF maneuvers to touchdown on the aim point on runway with a normal flare and landing.
4. After touchdown, lower the nosewheel to the runway while retarding thrust to idle.
5. After nosewheel touchdown, apply normal braking until below 80 knots, maintaining runway centerline.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.
2. Call out rudder hardover.

Date: __________ **Pilot:** ________________ **Runs:** __________

Evaluation Segment: Precision Landing
Start Evaluation: 200 ft AGL, Landing Speed, Descending
End Evaluation: Nosewheel touchdown

Long CHR	Lat / Dir CHR

Evaluation Basis: Evaluate handling qualities in landing. For desired performance, there should be no tendency to PIO or bobble in pitch or roll. There should also be no tendency to float or bounce after touchdown.There should be no geometry strikes on touchdown.

Performance Standards	Target	Desired	Adequate
Deviation from Approach Airspeed at 50 ft (kt)	0	±5	±10
Deviation from Runway Heading at touchdown (deg)	0	±3	±6
Longitudinal distance from threshold at touchdown (ft)	1250	1000-1500	750-2250
Lateral offset from runway centerline at touchdown (ft)	0	±10	±27
Sink Rate at touchdown (ft/sec)	<1	≤4	≤7
Maximum Bank Angle below 50 ft AGL (deg)	0	±5	±7
Pilot Induced Oscillations (PIO)	No PIO	No PIO	Not Divergent
Geometry Strikes (tail, engine nacelle, wing tip)	No Strikes	No Strikes	No Strikes

7254 Precision Landing/Rudder Hardover during Rollout

Flight Phase	MTE	Weather State	Failures
17A. Landing	303. Precision Landing	1. Light Turb.	113. All Rudder panels
Loading: 7. MFC - Final Cruise condition			

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Light/ None	0	Unlimited/ Unlimited	Dry, grooved	400 ft AGL; On LOC & G/S

ALT	400 AGL	Vapp	159	PSCAS	NORMAL
KEAS/M	157	Vref	154	RSCAS	NORMAL
GW	384,862	Vg/a	159	A/T	ON
C.G.	53.2	Vmin	125	HUD	ON
GEAR	DOWN			F/D	OFF
LEF/TEF	Auto			Config	*Ref H Cyc 3*

Abnormals/Exceptions:
Rudder Hardover after main gear touchdown.

Procedure–Evaluation Pilot (PF):
1. PF establishes aircraft in steady descending flight at the noted conditions.
2. PF tracks G/S and LOC using HUD.
3. At appropriate altitude, PF maneuvers to touchdown on the aim point on runway with a normal flare and landing.
4. After touchdown, lower the nosewheel to the runway while retarding thrust to idle.
5. After nosewheel touchdown, apply normal braking until below 80 knots, maintaining runway centerline.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.
2. Call out rudder hardover.

Date: ____________ **Pilot:** ____________________ **Runs:** __________

Evaluation Segment: Precision Landing
Start Evaluation: 200 ft AGL, Landing Speed, Descending
End Evaluation: Nosewheel touchdown

Long CHR	Lat / Dir CHR

Evaluation Basis: Evaluate handling qualities in landing. For desired performance, there should be no tendency to PIO or bobble in pitch or roll. There should also be no tendency to float or bounce after touchdown. There should be no geometry strikes on touchdown.

Performance Standards	Target	Desired	Adequate
Deviation from Approach Airspeed at 50 ft (kt)	0	±5	±10
Deviation from Runway Heading at touchdown (deg)	0	±3	±6
Longitudinal distance from threshold at touchdown (ft)	1250	1000-1500	750-2250
Lateral offset from runway centerline at touchdown (ft)	0	±10	±27
Sink Rate at touchdown (ft/sec)	<1	≤4	≤7
Maximum Bank Angle below 50 ft AGL (deg)	0	±5	±7
Pilot Induced Oscillations (PIO)	No PIO	No PIO	Not Divergent
Geometry Strikes (tail, engine nacelle, wing tip)	No Strikes	No Strikes	No Strikes

7261 **2-Axis Upset/Elevator Hardover (TE Up)**

Flight Phase	MTE	Weather State	Failures
7C. Supersonic Cruise	505. Simulated 2-Axis Gust Upset, High Speed	1. Light Turb.	111. Both elevator panels

Loading: 7. MFC - Final Cruise condition

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Light/ None	0	Unlimited/ Unlimited	Dry, grooved	N/A

ALT	64,000	R/C 0		PSCAS	NORMAL
KEAS/M	M 2.4			RSCAS	NORMAL
GW	384,862			A/T	OFF
C.G.	53.2			HUD	ON
GEAR	UP			F/D	OFF
LEF/TEF	Auto			Config	*Ref H Cyc 3*

Abnormals/Exceptions:
Elevator hardover (TE Up) during recovery from upset.

Procedure–Evaluation Pilot (PF):
1. Establish straight and level flight at M 2.4.
2. Reduce throttle to 50% and pull up gently to decelerate to M 2.3.
3. Establish a flight path angle of 6 degrees below the horizon, then roll to a bank angle of 15 degrees.
4. Maintain this attitude for 3 seconds.
5. Roll wings level.
6. Execute a 1.5 g pull-up to recover to level flight. Advance throttles to full to begin acceleration.
7. Terminate the maneuver after all transients have quiesed.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.
2. Count off 3 seconds after reaching M 2.4 and call out "Recover."
3. Trigger elevator hardover.
4. Call out elevator hardover.
5. Monitor load factor during recovery and provide feedback to PF if necessary to ensure a smooth 1.5 g recovery.

Date: ______ **Pilot:** ______ **Runs:** ______

Evaluation Segment: 2-axis Upset	Long CHR	Lat / Dir CHR
Start Evaluation: Straight and Level Flight (Cruise) End Evaluation: Straight Flight		

Evaluation Basis: Maneuver is possible without exceptional piloting strength or skill and without exceeding Md.

Performance Standards	Target	Desired	Adequate
Maximum Bank Angle (deg)	15	±5	±10
Maximum load factor during recovery (g)	1.5	1.5±0.2	1.5±0.5

2-Axis Upset/Flaperon Hardover

Flight Phase	MTE	Weather State	Failures
7C. Supersonic Cruise	505. Simulated 2-Axis Gust Upset, High Speed	1. Light Turb.	112. Two aileron Panels (Asymmetric)
Loading: 7. MFC - Final Cruise condition			

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Light/ None	0	Unlimited/ Unlimited	Dry, grooved	N/A

ALT	64,000	R/C	0	PSCAS	NORMAL
KEAS/M	M 2.4			RSCAS	NORMAL
GW	384,862			A/T	OFF
C.G.	53.2			HUD	ON
GEAR	UP			F/D	OFF
LEF/TEF	Auto			Config	*Ref H Cyc 3*

Abnormals/Exceptions:
Flaperon hardover during recovery from upset.

Procedure–Evaluation Pilot (PF):
1. Establish straight and level flight at M 2.4.
2. Reduce throttle to 50% and pull up gently to decelerate to M 2.3.
3. Establish a flight path angle of 6 degrees below the horizon, then roll to a bank angle of 15 degrees.
4. Maintain this attitude for 3 seconds.
5. Roll wings level.
6. Execute a 1.5 g pull-up to recover to level flight. Advance throttles to full to begin acceleration.
7. Terminate the maneuver after all transients have quiesed.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.
2. Count off 3 seconds after reaching M 2.4 and call out "Recover."
3. Trigger flaperon hardover.
4. Call out flaperon hardover.
5. Monitor load factor during recovery and provide feedback to PF if necessary to ensure a smooth 1.5 g recovery.

Date: ______ **Pilot:** ______ **Runs:** ______

Evaluation Segment:	2-axis Upset	Long CHR	Lat / Dir CHR
Start Evaluation:	Straight and Level Flight (Cruise)		
End Evaluation:	Straight Flight		

Evaluation Basis: Maneuver is possible without exceptional piloting strength or skill and without exceeding Md.

Performance Standards	Target	Desired	Adequate
Maximum Bank Angle (deg)	15	±5	±10
Maximum load factor during recovery (g)	1.5	1.5±0.2	1.5±0.5

30' Go-Around with Autoflap Failure

Date: ____________ Pilot: ______________________ Runs: ____________

Flight Phase	MTE	Weather State	Failures
17A. Landing	307. Go-Around - Min Alt Loss	301. Cat IIIa - Lt. Turb	115. All TEF Panels

Loading: 16. M3F - MZFW+Body Fuel+Wing Fuel, Fwd C.G.

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 0 Kt	Light/ None	3A	50 ft/ 600 ft	Dry, grooved	On G/S and LOC about 3 miles from touchdown, at 750 feet AGL

ALT	400 AGL	Vapp	159	PSCAS	NORMAL
KEAS/M	159	Vref	154	RSCAS	NORMAL
GW	384,862	Vg/a	159	A/T	ON
C.G.	47.3	Vmin	125	HUD	ON
GEAR	DOWN			F/D	OFF
LEF/TEF	Auto			Config	*Ref H Cyc 3*

Abnormals/Exceptions:
All TEF jammed at landing deflection.

Procedure–Evaluation Pilot (PF):
1. Establish aircraft on LOC and G/S.
2. Maintain Vapp.
3. Track LOC and G/S using HUD.
4. When PNF calls "Go-round," pitch nose up to capture a target flight path angle of 12°, while simultaneously pushing the TO/GA button and advancing throttles to go-around thrust. The time to initially acquire the target flight path angle should be 7 sec.
5. Terminate test when target climb pitch attitude has been established and stabilized.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.
2. During approach, PNF monitors any performance indicators that will not be automatically reported at the end of the run.
3. At 30 feet radio altitude, call out "Go-Around".
4. Call out flap failure.

Evaluation Segment:	Minimum Altitude Loss Go-Around	Long CHR	Lat / Dir CHR
Start Evaluation:	30' AGL, Final Approach Speed, Descending		
End Evaluation:	Stabilized Climb Flight Path		

Evaluation Basis: Evaluate the ability to go around from a very low altitude without contacting the runway with a minimum of airspeed loss. For desired performance, there should be no tendency to PIO or bobble in pitch or roll. There should be no geometry strikes

Performance Standards	Target	Desired	Adequate
Overshoot of Target Flight Path (deg)	0	±2	±3
Altitude Loss (ft)	<20	<20	<30
Bank Angle Control (deg)	0	±5	±10
Pilot Induced Oscillations	No PIO	No PIO	Not Divergent
Geometry Strikes (tail, engine nacelle, wing tip)	No Strikes	No Strikes	No Strikes

15 Kt Crosswind App & Ldg/75% Roll Loss

Flight Phase	MTE	Weather State	Failures
17A. Landing	313. Complete Approach and Landing	30. 15 Kt Crosswind	114. All Flaperon Panels

Loading:	7. MFC - Final Cruise condition				
Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 15 Kt	Moderate/ None	0	Unlimited/ Unlimited	Dry, grooved	1/2 mi outside OM, at 1,500 feet AGL, on LOC.

ALT	1,500	Vapp	159	PSCAS	NORMAL
KEAS/M	159	Vref	154	RSCAS	NORMAL
GW	384,862	Vg/a	159	A/T	ON
C.G.	53.2	Vmin	125	HUD	ON
GEAR	DOWN			F/D	OFF
LEF/TEF	Auto			Config	*Ref H Cyc 3*

Abnormals/Exceptions:
75 % loss of roll control during approach.

Note: X-wind decreases linearly from 25 kt at 1000 ft AGL to 15 kt at field elevation.

Procedure–Evaluation Pilot (PF):
1. Establish aircraft in steady level flight at the noted conditions, tracking the LOC for G/S intercept.
2. Maintain Vapp.
3. Track LOC to G/S intercept and capture G/S using HUD or PFD.
4. Procedure A: Disconnect autothrottles at 50 ft AGL.
5. Procedure A: At 50 ft AGL, manually retard throttles and initiate a decrab and flare maneuver to touchdown at the target point. Max bank angle 5 deg.
6. Procedure B: At 200 ft AGL, initiate a forward slip (max bank angle 5 deg).
7. Procedure B: Disconnect autothrottles at 50 ft AGL.
8. Procedure B: Manually retard throttles and execute a flare to touchdown at the target point on the runway. Max bank angle is 5 deg.
9. After touchdown, retard throttles to idle and lower the nosewheel to the runway.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.
2. During approach, PNF monitors any performance indicators that will not be automatically reported at the end of the run.
3. Call out flaperon failure.

Date: ______ **Pilot:** ______ **Runs:** ______

Evaluation Segment:	Precision Landing	Long CHR	Lat / Dir CHR
Start Evaluation:	200 ft AGL, Landing Speed, Descending		
End Evaluation:	Nosewheel touchdown		

Evaluation Basis: Evaluate handling qualities in landing. For desired performance, there should be no tendency to PIO or bobble in pitch or roll. There should also be no tendency to float or bounce after touchdown.There should be no geometry strikes on touchdown.

Performance Standards	Target	Desired	Adequate
Deviation from Approach Airspeed at 50 ft (kt)	0	±5	±10
Deviation from Runway Heading at touchdown (deg)	0	±3	±6
Longitudinal distance from threshold at touchdown (ft)	1250	1000-1500	750-2250
Lateral offset from runway centerline at touchdown (ft)	0	±10	±27
Sink Rate at touchdown (ft/sec)	<1	≤4	≤7
Maximum Bank Angle below 50 ft AGL (deg)	0	±5	±7
Pilot Induced Oscillations (PIO)	No PIO	No PIO	Not Divergent
Geometry Strikes (tail, engine nacelle, wing tip)	No Strikes	No Strikes	No Strikes

7292 15 Kt Crosswind App & Ldg/Flaperon Hardover

Flight Phase	MTE	Weather State	Failures
17A. Landing	313. Complete Approach and Landing	30. 15 Kt Crosswind	112. Two aileron Panels (Asymmetric)

Loading: 7. MFC - Final Cruise condition

Head/X Wind, kt	Turb/ Gusts	Approach Category	Ceiling/ Visibility	Rwy Surface	Initial Position
0 Kt/ 15 Kt	Moderate/ None	0	Unlimited/ Unlimited	Dry, grooved	1/2 mi outside OM, at 1,500 feet AGL, on LOC.

ALT	1,500	Vapp	159	PSCAS	NORMAL
KEAS/M	159	Vref	154	RSCAS	NORMAL
GW	384,862	Vg/a	159	A/T	ON
C.G.	53.2	Vmin	125	HUD	ON
GEAR	DOWN			F/D	OFF
LEF/TEF	Auto			Config	*Ref H Cyc 3*

Abnormals/Exceptions:
Flaperon hardover during approach.

Note: X-wind decreases linearly from 25 kt at 1000 ft AGL to 15 kt at field elevation.

Procedure–Evaluation Pilot (PF):
1. Establish aircraft in steady level flight at the noted conditions, tracking the LOC for G/S intercept.
2. Maintain Vapp.
3. Track LOC to G/S intercept and capture G/S using HUD or PFD.
4. Procedure A: Disconnect autothrottles at 50 ft AGL.
5. Procedure A: At 50 ft AGL, manually retard throttles and initiate a decrab and flare maneuver to touchdown at the target point. Max bank angle 5 deg.
6. Procedure B: At 200 ft AGL, initiate a forward slip (max bank angle 5 deg).
7. Procedure B: Disconnect autothrottles at 50 ft AGL.
8. Procedure B: Manually retard throttles and execute a flare to touchdown at the target point on the runway. Max bank angle is 5 deg.
9. After touchdown, retard throttles to idle and lower the nosewheel to the runway.

Procedure–Test Engineer / Pilot Not Flying (PNF):
1. Confirm initial conditions.
2. During approach, PNF monitors any performance indicators that will not be automatically reported at the end of the run.
3. Call out flaperon hardover.

Date: ____________ **Pilot:** ______________________ **Runs:** __________

Evaluation Segment: Precision Landing		Long CHR	Lat / Dir CHR
Start Evaluation:	200 ft AGL, Landing Speed, Descending		
End Evaluation:	Nosewheel touchdown		

Evaluation Basis: Evaluate handling qualities in landing. For desired performance, there should be no tendency to PIO or bobble in pitch or roll. There should also be no tendency to float or bounce after touchdown.There should be no geometry strikes on touchdown.

Performance Standards	Target	Desired	Adequate
Deviation from Approach Airspeed at 50 ft (kt)	0	±5	±10
Deviation from Runway Heading at touchdown (deg)	0	±3	±6
Longitudinal distance from threshold at touchdown (ft)	1250	1000-1500	750-2250
Lateral offset from runway centerline at touchdown (ft)	0	±10	±27
Sink Rate at touchdown (ft/sec)	<1	≤4	≤7
Maximum Bank Angle below 50 ft AGL (deg)	0	±5	±7
Pilot Induced Oscillations (PIO)	No PIO	No PIO	Not Divergent
Geometry Strikes (tail, engine nacelle, wing tip)	No Strikes	No Strikes	No Strikes

Appendix C. Controls Allocation Document

The attached pages represent the manner in which the control surfaces are utilized to provide flight control functions.

Appendix C. Controls Allocation for LaRC.1

Actuator model

The actuator model used for LaRC.1 includes the effect of aerodynamic hinge moments on rate and position authority, and includes blow-back of control surfaces at sufficiently high dynamic pressure and surface extensions.

Controls Mixer

Longitudinal

The total pitch command from the control system (both pilot and SAS components) are used to command the elevator and stabilizer in a 2:1 gearing - that is, a 10 degree elevator trailing-edge-up command yields a 5 degree stabilizer trailing-edge-up command.

Lateral/Directional

For LaRC.1, trailing edge flaps 1, 2, 3 on the left wing and 6, 7, 8 on the right wing are used as flaperons.

Flap Logic

Takeoff flap setting

For takeoffs, the flaps are fixed at 30° leading edge and 10° trailing edge (30/10).

Landing flap setting

The landing flap setting is fixed at 0° leading edge and 30° trailing edge (0/30). If the speedbrake handle is raised prior to touchdown (ground armed position) the flaps will retract at maximum rate when weight-on-wheels is detected.

Flap extension/retraction logic

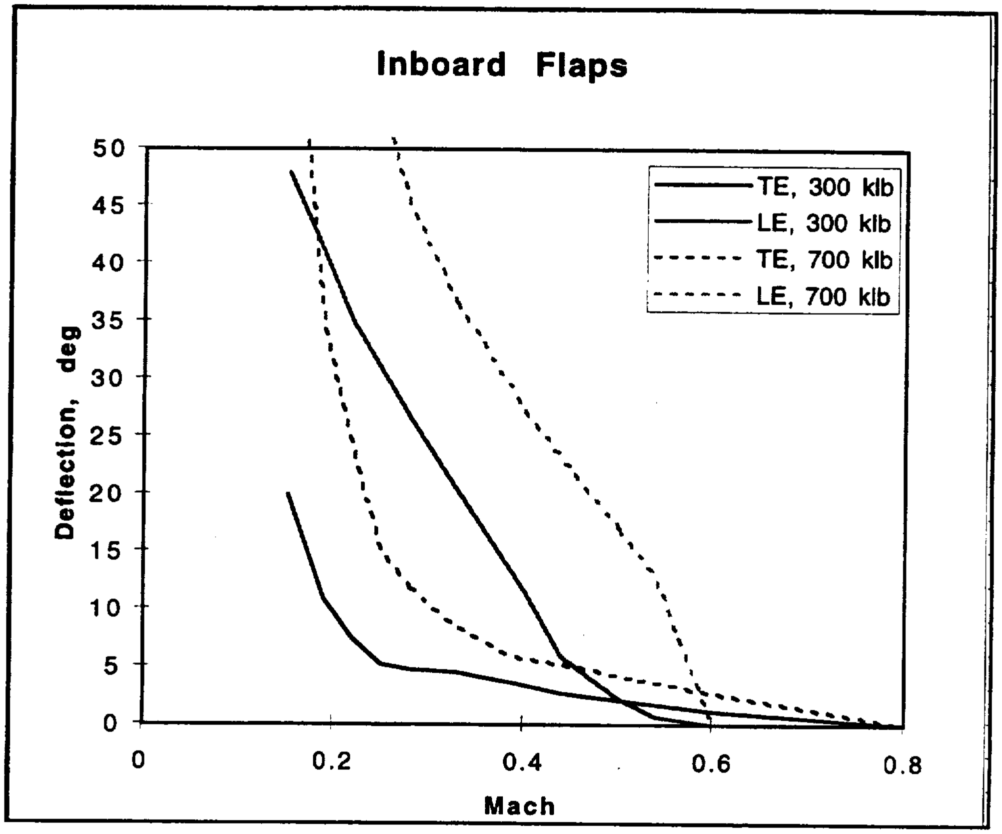
On landing, the flaps convert from automatic to landing settings starting at 390 feet gear height over 18 seconds for most tasks; the decelerating approaches use a different time scale so that the reconfiguration takes place over the entire approach. On takeoff the flaps reconfigure from takeoff to automatic flap schedule starting above 35 ft gear height over a period of 18 seconds. In a go-around situation, the flaps reconfigure from landing settings to the appropriate takeoff or auto schedule over 18 seconds after the TOGA button is depressed.

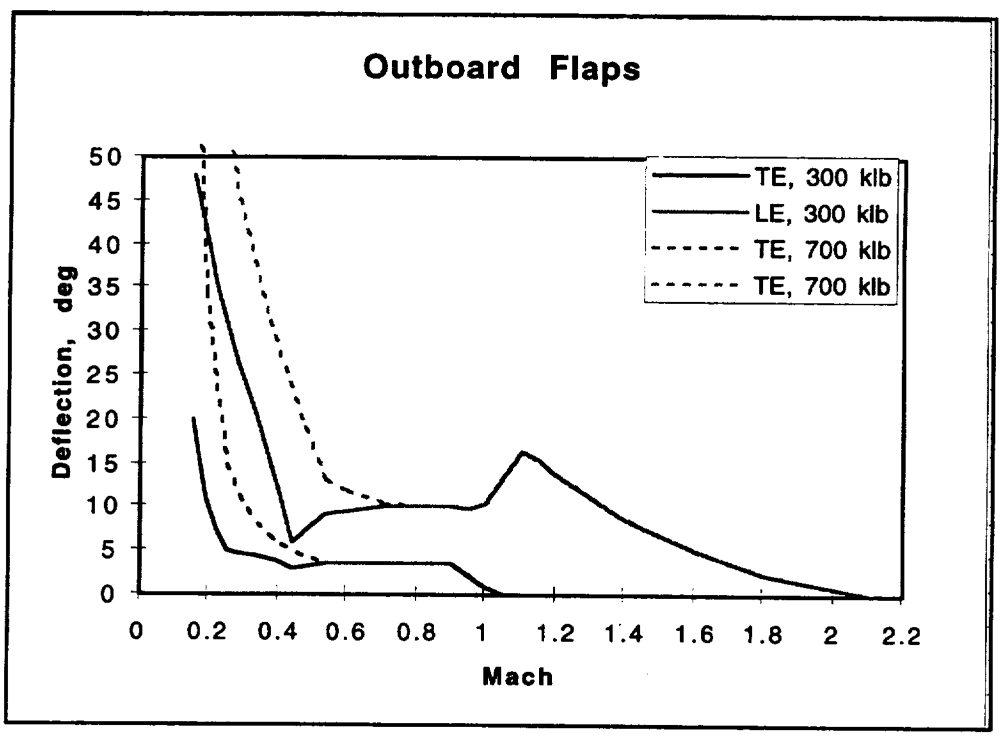
Autoflap schedule

The automatic flap schedule is used for all flight envelopes except landing and takeoff, or as noted on the flight cards. The schedule was extracted from a document by Brett Churchill of Boeing, and are separate functions of weight and Mach for inboard and outboard leading and trailing edge flaps.

This nominal flap schedule is further modified by a low-speed function, based upon angle of attack. If angle-of-attack goes above a 15 degrees, the automatic flap schedule is modified with a minimum deflection value (a function of angle-of-attack) (not shown).

The nominal (low angle-of-attack) automatic flap schedules are shown below:





Vortex Fence

The vortex fence is used to assist in improving nose-down trim during landings and assisting in rotation during takeoff. The fence extends during takeoff when Vr is reached and the stick is moved aft of center, and retracts when either the gear is off the ground or desired rotation pitch attitude is reached. The rotation fence operation is rate limited such that full extension or retraction takes one second while weight is on the wheels, and 3 1/3 seconds if in the air.

During landing, the fence extends over 18 seconds starting at 390 feet gear height in sync with the flap reconfiguration, and stows during landing rollout.

Spoiler/Slot deflectors

The Spoiler/Slot deflectors (SSDs) are not used for roll control, but are available to function as speedbrake for most tasks.

Landing mode

In most landing tasks, the speedbrake handle can be armed for ground spoilers by raising the speedbrake handle prior to touchdown. When weight-on-wheels is first detected, the flaps retract and the spoilers extend.

Emergency Descent

In the emergency descent task, the spoilers should be deployed fully. A variable amount of drag can be programmed for the "generic drag device" so that the amount of drag required to perform the emergency descent within the time limits imposed by Federal Aviation Regulations can be studied.

Rate and Position Limits for actuators

Actuator	Rate limit deg/sec	Position limits (deg) negative	positive
Elevator	50	–30	+30
Stabilizer	25	–15	+15
Flaperons*	50	–30	30
LE flaps	15	0	+50
TE flaps 4 & 5	15	0	+30
Rudder	50	–30	+30
Vortex Fence	90	0	+70

*(T.E. 1, 2, 3, 6, 7, 8)

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13. ABSTRACT *(Maximum 200 words)*

This document describes the purpose of and method by which an assessment of the Boeing Reference H High-Speed Civil Transport design was evaluated in the NASA Langley Research Center's Visual/Motion Simulator in January 1997. Six pilots were invited to perform approximately 60 different Mission Task Elements that represent most normal and emergency flight operations of concern to the High Speed Research program. The Reference H design represents a candidate configuration for a High-Speed Civil Transport, a second generation supersonic civilian transport aircraft. The High-Speed Civil Transport is intended to be economically sound and environmentally safe while carrying passengers and cargo at supersonic speeds with a trans-Pacific range. This simulation study was designated "LaRC.1" for the purposes of planning, scheduling, and reporting within the Guidance and Flight Controls super-element of the High-Speed Research program. The study was based upon Cycle 3 release of the Reference H simulation model.

14. SUBJECT TERMS
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